A

CONSPECTUS

OF THE

MEDICAL SCIENCES:

COMPRISING

MANUALS

OF

ANATOMY, PHYSIOLOGY, CHEMISTRY, MATERIA MEDICA, PRACTICE OF MEDICINE, SURGERY, AND OBSTETRICS.

FOR THE

USE OF STUDENTS.

BY

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SECOND EDITION,

ENLARGED AND THOROUGHLY REVISED.

WITH FOUR HUNDRED AND SEVENTY-SEVEN ILLUSTRATIONS.

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PREFACE

TO THE SECOND EDITION.

In revising the Conspectus for a new edition, considerable labor has been found necessary to adapt the work to the present state of science and of medical teaching. In the Manual of Anatomy, but little addition or alteration was required, beyond the introduction of a number of new illustrations, selected from works of recognized authority. In that of Physiology, I have endeavored to embody the recent advances of the science, so far as they appear to me to have been fairly established; a somewhat more independent attitude being maintained, however, in the authorship of this than in that of the other manuals.

The greatest amount of change has been called for in the Manual of Chemistry. While a majority of teachers in this department have adopted the "New Chemistry," all have not done so. It has appeared desirable, therefore, for the *means of transition* from the old to the new system to be furnished to the student. I have attempted this, in a section upon the "Ideas of Modern Chemistry;" and also by giving, in almost all instances throughout the Manual, *both* the old and the new equivalents and formulæ of important substances and reactions.

In the Manual of Materia Medica fourteen new articles have been added, a few of minor consequence omitted, and the nomenclature has been made to conform to the last edition of the U. S. Pharmacopœia.

In the Manual of Practice a number of minor changes have been made; with a few additions, and an increase in the

number of illustrations. The same is true of the Manual of Surgery, the chief addition to which is a short chapter upon Skin-Grafting.

Considerable new matter has been added to the Manual of Obstetrics; especially upon three topics: Surgical Diseases of Women; Rupture of the Perineum; and Ovarian Tumors.

While important additions have thus been made to the work, a change in the typographical arrangement has prevented an undue increase in the size of the volume. By the pains expended in revising carefully the whole book, I am enabled to hope that, although not, as in the preparation of the first edition, aided by collaborators, I have rendered the Conspectus more fitted for the reliance of students, in the special place which it was designed to fill. It is also possible that some practitioners, of scanty leisure, may find it useful, at least for occasional reference.

H. H.

MAY, 1874.

PREFACE

TO THE FIRST EDITION.

EXPERIENCE shows that the thorough perusal of *extended* text-books by students, during the months of their attendance upon medical lectures, is impracticable. The time for such study, eminently important as it undoubtedly is, must be before and after that period. Hence, the preparation of manuals for use in connection with lectures, and for subsequent review, is a legitimate although humble part of the work of a medical teacher and writer. It is the aim of this "Conspectus" to give, in as brief a form and as clear a manner as possible, the indispensable elements of a course of medical study, as taught in the colleges, and conveyed in approved text-books. Upon this plan, not only is originality not sought for, but individuality of opinion is intentionally excluded; and no merit but that of careful compilation and condensation is claimed for the work.

In regard to authorship, the name upon the title-page might be rather announced as that of the *editor* than of the writer of the book; since only three of the seven parts or "manuals" have been prepared by his hand; those upon *Anatomy*, *Physiology*, and *Practice of Medicine*. The others were intrusted to gentlemen whose special studies gave reason for confidence in their execution of the task in each case to the best advantage of the student. Of those to whom acknowledgment is due for this obligation, permission is given only to name Dr. Harrison Allen, Professor of Comparative Anatomy and Zoology in the University of Pennsylvania, and one of the surgical staff of Wills Hospital; and Mr. William M. Spack-

man, of Philadelphia. The former has contributed the whole of the Manual of Surgery. The latter, the portion of the Manual of Chemistry which treats of the Non-Metallic Elements or Metalloids. Throughout the whole work, great care has been taken to secure accuracy as well as lucidity of statement, and as near an approach to completeness as the limits of the plan will allow; so that it may be as little as possible amenable to the objections of those whose opinion is unfavorable to the use of any but the most elaborate treatises by the student at any period.

H. H.

JANUARY, 1869.

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ANATOMY.

Anatomy is the science of the *structure* of the human, or of any other, organized body; of all the parts or organs of which it is composed, and their relative positions in it.

Comparative Anatomy includes the study of the organization of other animals with that of man.

General Anatomy, *Histology*, and *Microscopic* Anatomy study respectively the *plan* of structure of the body, the *tissues* of which it is composed, and its *minute* elements.

Special or *Descriptive* Anatomy gives account of the particular organs and all their relations.

Regional or *Surgical* Anatomy takes into consideration the local relations of important parts, especially with a view to surgical operations.

In Descriptive Anatomy, the different organs may be studied as follows: 1. Bones; 2. Articulations; 3. Viscera; 4. Vessels; 5. Tegument; 6. Muscles; 7. Nerves; 8. Organs of Sense.

CHAPTER I.

BONES.

OSSEOUS TISSUE.

Composition.

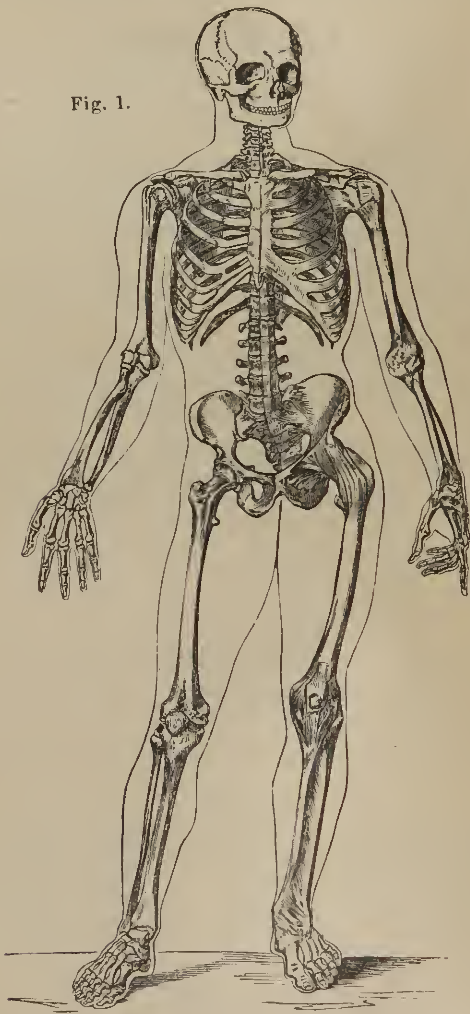
In bone, *earthy* and *animal* constituents are intimately combined. Of the former there are about 66.7 parts to 33.3 of the latter. Phosphate of calcium is the most abundant mineral material; being about 51 parts in the 100 of bone. Carbonate of calcium 11.3 parts; fluoride of calcium 2 parts. The animal matter of bone is gelatinous, allied to cartilage; originally every bone is developed from cartilage, by *ossification*.

The mineral matter of bone increases with age, making the bones of the old more brittle. There is more of it also in some bones, and parts of bones, than in others.

Structure.

Bones are *long*, *thick*, or *flat* in shape. In the long bones especially, we distinguish a *compact* and a *cellular* structure; the latter

Fig. 1.



Human Skeleton.—Ligaments removed from the right half; remaining on the left.

at the ends, which are expanded. The shaft of a long bone, which is hollow, is called its diaphysis; each end, an epiphysis; any other projection, a process or apophysis.

When a bone is cut transversely, we see distinctly, with the aid of a microscope, canals (of *Havres*) running in the direction of its length, and communicating laterally, through radiating lesser channels, with minute reservoirs called the *corpuscles of Purkinje.* The

Fig. 2.

TRANSVERSE SECTION OF HUMERUS. (Magnified.)

nutrition of the bone is secured, by the liquor sanguinis or blood-lymph passing through these canals and cells, from the branches of the artery or arteries, which do not penetrate to nearly all its parts. The foramina or holes upon the surfaces of bones are for their vessels.

By the shafts of the long bones being of compact substance, and hollow, while the ends are cellular and enlarged, the greatest strength is obtained, with economy of material; while the articulations are thus adapted for motion as well as support. The principle of the hollow shaft is illustrated elsewhere, in nature, in the stems of the grasses; and in art, in the tubular bridge.

The *marrow* of bones is a peculiar fatty substance. Bones are covered closely, and lined, by the external and internal *periosteum.* This is a delicate and yet firm membrane, supplied with bloodvessels, and of great importance to the development, nutrition, and repair of the bone itself.

Development.—In the fœtus, bones commence their formation in *temporary cartilages;* in these, as they grow, osseous matter is deposited at and around the *points or centres of ossification;* which are different in number according to the complexity of the bone.

Fig. 3.

Short bones may have but one such centre. The long bones have one for the shaft or *diaphysis*, and one for each terminal *epiphysis*. The union between the ends and shaft occurs at puberty or during adolescence. Some flat bones, as the frontal, and those of the pelvis, are in early life composed of separate parts, which afterwards are consolidated together.

Bones continue to undergo absorption and renewal of their particles through life; as interesting experiments upon animals have shown.

Number.

In the adult skeleton there are 206 bones, exclusive of the sesamoid and Wormian bones, which are not uniform in number. They are, of the

Cranium	8
Bones of the ear	6
Face	14
Os hyoides and sternum	2
Ribs	24
Vertebral column	26
Upper extremities	64
Lower extremities	62
	206

The most convenient classification of the parts of the skeleton is into the Head, Trunk, and Extremities. The divisions of the Trunk are, the Spine, Thorax, and Pelvis.

THE SPINE.

In man, the spinal column has four curves; it is convex anteriorly in the neck, concave in the thorax, convex again in the lumbar region, and concave in the pelvis. It is smaller above, the bodies of the vertebræ increasing in size almost regularly from the neck to the sacrum. The vertebræ are separated from each other by the *intervertebral cartilages*, but firmly connected by ligaments. The *spinal*

Lateral View of the Spinal Column.—1. Atlas. 2. Dentata. 3. Seventh cervical vertebra. 4. Twelfth dorsal vertebra. 5. Fifth lumbar vertebra. 6. First piece of sacrum. 7. Last piece of sacrum. 8. Coccyx. 9. A spinous process. 10, 10. Intervertebral foramina.

cord is contained within, and protected by, the spinal column; the nerves and bloodvessels of the cord passing through the intervertebral foramina.

There are 24 true, and 4 or 5 *false* vertebræ. Those called false are scarcely movable; viz., the sacrum, and 3 or 4 bones of the coccyx.

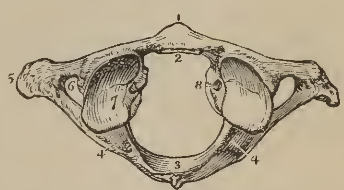
Each vertebra has a body and 7 processes. The processes are, 1 *spinous*, pointing backwards; 2 *transverse;* and 4 *oblique* or articulating processes. Of the last, 2 are above and 2 below. The body of the vertebra is in front of the foramen for the spinal cord.

Seven Cervical Vertebræ.

Small bodies; spinous processes thick, short, straight, and bifid at the end. Transverse processes have each a foramen for the vertebral vessels. Oblique processes oval, the superior ones looking upwards and backwards, the inferior, downwards and forwards. The spinal foramen is larger in the cervical than in any other portion of the spine, for free motion of the neck without injury to the cord.

The first vertebra, or *atlas*, is a bony ring merely, with only a tubercle in place of the spinous process; long transverse processes; upper oblique processes, large and concave, to receive the condyles of the occipital bone. The lower oblique processes are round and flat. Its spinal foramen is the largest of all.

Fig. 4.



THE ATLAS.—1. Anterior tubercle. 2. Articular face for the dentata. 3. Posterior surface of spinal canal. 4, 4. Intervertebral notch. 5. Transverse process. 6. Foramen for vertebral artery. 7. Superior oblique process. 8. Tubercle for the transverse ligament.

The second, *vertebra dentata*, or *axis*, has the odontoid or dentate process rising from its body to enter the ring of the atlas, where it is confined by a ligament. Its spinous process is long and bifid.

The sixth and seventh cervical vertebræ are remarkable for the length of their spinous processes; that of the seventh is the longest. The foramen in its transverse process only gives passage to the vertebral vein; not to the artery.

Twelve Dorsal Vertebræ.

Bodies diminish in diameter from 1st to 3d, then increase to the last.

The 1st, 11th, and 12th have each a complete mark or *fossa* for a rib. Each of the others receives part of the end of one rib above, and part of the end of another below. The oblique processes, so called, are perpendicular; the upper one looking backwards, and the lower ones forwards. Transverse processes long, with marks in front for the junction of the ribs; except the 11th and 12th.

Fig. 5.

A Dorsal Vertebra.—1. The body. 2. Face for the head of a rib. 3. Superior face of the body. 4. Superior half of the intervertebral notch. 5. Inferior half of the intervertebral notch. 6. Spinous process. 7. Articular face for the tubercle of a rib. 8. Two superior oblique processes. 9. Two inferior oblique processes.

Fig. 6.

View of a Lumbar Vertebra.—1. Face for the intervertebral substance. 2. Anterior surface of the body. 3. Spinous process. 4. Transverse process. 5. Oblique process. 6. A portion of the bony bridges. 7. The spinal foramen.

Spinous processes long, pointed, and overlapping, as if pressed downwards.

Five Lumbar Vertebræ.

Large bodies, especially so in transverse diameter. Articulating processes vertical, upper ones looking inwards, lower ones outwards, so as to *interlock* the vertebræ. Transverse processes long and straight. Spinous processes short, straight, thick.

Sacrum.

A wedge-shaped bone with its base above ; concave in front, convex and rough behind. Being formed of five vertebræ compacted together, the marks of their union exist ; incomplete spinous and oblique processes and foramina, four in front and four behind, on each side, for the nerves. The spinal marrow (here called *cauda equina*) is continued into a canal in the sacrum. The *base* of the sacrum closely resembles a lumbar vertebra. Its *sides* are rough, for junction with the ilia. Its *apex* has a surface for articulation with the coccyx.

Os Coccygis.

The coccyx consists of either three or four small bones, which frequently in the adult are united into a firm piece with the sacrum. They diminish in size from the first to the last.

THE HEAD.

There are, of the *cranium*, eight bones ; of the *face*, fourteen.

CRANIUM.

The eight bones are, the frontal, two parietal, two temporal, occipital, sphenoid, and ethmoid. Each is composed of an *external and internal* table, and a *diploë*, or cellular structure between these.

Frontal Bone.

Convex outside ; on each side in front a slight, round protuberance, marking the *puncta ossificationis;* the *orbitar ridge* on either side below, terminating externally in the *external angular process*, and on the nasal side in the *internal angular process.* Below and between the internal angular processes is the *nasal spine.* The *orbitar processes*, passing backwards from the orbitar ridges, roof the orbits of the eyes.

The internal surface of this bone has marks for the convolutions of the brain, and, along its middle, a ridge for the connection of the dura mater, and a fossa for its superior longitudinal sinus ; the *foramen cæcum* is the passage for the vein in which this sinus begins in front.

The *frontal sinuses* are cavities, above the orbitary ridges, between the tables of the bone, and communicating with cavities in the ethmoid bone. They vary in size.

The most notable *foramen* of this bone is the *supra-orbital* foramen, which is sometimes only a notch, over the middle of each brow ; it transmits the supra-orbital artery and nerve.

The frontal bone *articulates* with the two parietal, the sphenoid, ethmoid, nasal, upper maxillary, lachrymal, and malar. This bone is double, laterally, in infancy ; the two halves uniting into one as life advances.

Two Parietal Bones.

These are four-sided bones, forming the lateral walls of the skull. The *parietal protuberance*, on each, marks the point of ossification. The lower portion, outside, is overlapped by the squamous portion of the *temporal* bone.

Between the upper edges of the two parietal bones is formed the groove for the superior longitudinal sinus of the dura mater.

Behind, the parietal bones connect with the *occiput;* below and in front, by an angular projection, with the *sphenoid;* in front and above, with the *frontal.*

Internally, these bones show marks of convolutions of the brain, and others for the middle artery of the dura mater.

Occiput.

Of rounded form, between and below the parietals, this bone forms the back of the head. It is the thickest of the cranial bones. Outside, is the *external occipital cross;* within, a corresponding *internal cross.*

The *foramen magnum occipitis* is the large opening for the spinal marrow, vertebral artery, and spinal accessory nerves to pass through. Anterior to it is the *basilar process*, going forwards to join with the sphenoid bone.

The *condyloid processes* are on each side of the foramen magnum, resting upon the atlas.

The *anterior condyloid foramen* transmits the ninth or hypoglossal nerve ; through the *posterior* condyloid foramen a vein passes to the lateral sinus of the dura mater.

The cross on the internal surface of the occiput is very prominent, giving origin to grooves for sinuses of the dura mater. The posterior lobes of the cerebrum rest upon the superior portions of the concavity of the bone, as marked by the cross; the two halves of the cerebellum are supported by the inferior portions.

The occipital bone articulates with the *two parietal*, the *sphenoid*, and the *two temporal*. The *jugular eminence* is on its lower edge, on each side. Before this is the fossa, which by union with the temporal bone is converted into the *posterior foramen lacerum;* through this pass the eighth nerve and the internal jugular vein.

Two Temporal Bones.

Each of these is composed of a *squamous*, *mastoid*, and *petrous* portion.

The *squamous* part is thin, and partly overlaps the parietal bone. The temporal artery grooves its external surface; which is covered by the temporal muscle. The zygomatic process projects forward from the middle of the exterior of the bone, to form the *zygomatic arch* with a process of the malar bone.

Fig. 7.

Left Temporal Bone.—1. Squamous portion. 2. Mastoid portion. 3. Petrous portion. 4. Zygomatic portion. 5. Tubercle. 6. Temporal ridge. 7. Glenoid fissure. 8. Mastoid foramen. 9. Meatus auditorius externus. 10. Fossa for digastric muscle. 11 Styloid process. 12. Vaginal process. 13. Glenoid foramen. 14. Groove for Eustachian tube.

Beneath the base of this process is the *glenoid cavity* for the articulation with the inferior maxillary bone. Just behind this cavity is the *Glaserian fissure;* back of this, a fossa containing part of the parotid gland. The laxator tympani muscle, and nerve called chorda tympani, pass through the fissure.

The middle artery of the dura mater marks deeply the internal surface of the squamous portion of the temporal bone.

The mastoid (nipple-like) part is behind the ear. It is of a cellular structure, with dentate edge. Outside are the mastoid process and digastric fossa; internally, above, the mastoid foramen; through which passes a vein.

The shape of the *petrous* portion is that of a pyramid, pointing inwards and forwards. The name is given on account of its hardness. It has a *base*, *apex*, *inferior*, *anterior*, and *posterior surfaces*.

In the base is the external *meatus auditorius*, surrounded by a rim for the attachment of the aural cartilages. In the apex is an opening at the end of the canal for the internal carotid artery. The *Eustachian tube* is completed by the junction between the petrous

and the squamous parts of the bone; the tensor tympani muscle passes above it.

On the anterior surface is a groove and a foramen, *hiatus Fallopii*, for the superficial petrous branch of the Vidian nerve; also an eminence from the bulging of the labyrinth of the ear. The superior petrosal sinus marks the internal edge; the ganglion of Casser rests upon a depression near the apex.

From the inferior surface goes downwards and forwards the *styloid process*. The *stylo-mastoid foramen* is between it and the mastoid portion. The facial part of the seventh nerve, a small branch of the fifth nerve, and the stylo-mastoid artery pass through the stylo-mastoid foramen. Towards the occiput is the *jugular fossa;* which, when joined to the occipital bone, makes the *posterior foramen lacerum*. Through this pass the eighth nerve and jugular vein. Into it opens the *tympanic canal*, with the *nerve of Jacobson*.

The *carotid canal* winds through the petrous portion, beginning in front of the jugular fossa. In it, besides the carotid artery, is the *ganglion of Laumonier*. The opening for the *aqueduct of the cochlea* is between the carotid canal and the jugular fossa.

In the middle of the posterior surface is the *internal meatus auditorius*. A notch or foramen above this transmits a small artery. The *aqueduct of the vestibule* opens upon this surface.

Sphenoid Bone.

This acts as a *girder* in the architecture of the skull, crossing its base, and holding all of the other bones together. It has a body, four wings, and two descending processes. On the upper surface of the body is the *sella turcica* (Turkish saddle), in which rests the pituitary gland. Behind and over this is the posterior clinoid process; at the sides pass the *sulci carotici*, for the carotid arteries. The *olivary process* is a prominence anterior to the sella turcica, and having upon it a mark for the chiasm or junction of the optic nerves.

The nasal lamella of the ethmoid bone articulates with a ridge upon the front of the body of the sphenoid. On each side of this ridge, in the adult skull, is an orifice, belonging to one of the *sphenoidal cells*, which communicate with the posterior ethmoidal cells. The *azygos process* on the lower surface of the body of the sphenoid joins with the vomer.

Behind, the sphenoid articulates, by a rough surface, with the cuneiform process of the occiput.

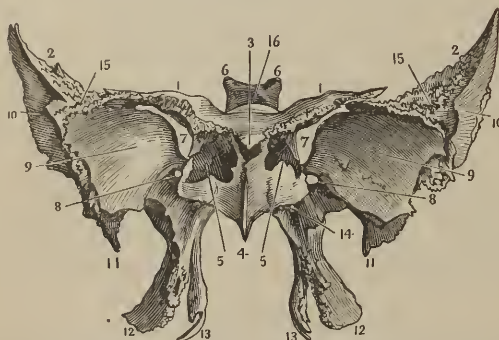
The *greater wings* of the sphenoid have each three surfaces, the *temporal*, *orbital*, and *cerebral*. The *temporal* is external; it has a process anteriorly, and is traversed by a ridge. The temporal and external pterygoid muscles lie over it. The *orbital* or anterior surface contributes a large space to the orbit of the eye. Above, by a triangular serrated portion, this connects with the frontal bone. The temporal bone joins it at the side.

On the concave *cerebral* surface are marks for the convolutions of the middle lobe of the cerebrum. Through it, by the *foramen rotundum*, passes the second branch of the fifth pair of nerves. The third branch of the fifth goes through the *foramen ovale*. The *spinous process* terminates this surface behind; and through it,

by the *foramen spinale*, passes the middle artery of the dura mater. The lower point of the spinous process is called the styloid process of the sphenoid bone.

The *sphenoidal fissure* lies between the greater and the lesser wings. Through it pass the third, fourth, first branch of the fifth, and sixth pairs of nerves.

Fig. 8.



ANTERIOR AND INFERIOR SURFACE OF THE SPHENOID BONE.—1, 1. Apophyses of Ingrassias. 2, 2. The great wings. 3. Ethmoidal spine. 4. Azygos process. 5. Sphenoidal cells, after removal of pyramids of Wistar. 6. Posterior clinoid processes. 7. Sphenoidal fissure.

The *lesser wings*, or apophyses of Ingrassias, are in front of the greater, and are three-sided. Posteriorly they present the *anterior clinoid processes;* through these pass, by the *optic foramina*, the optic nerves and ophthalmic arteries. The frontal bone articulates with these processes anteriorly.

Downward, on each side, project the *pterygoid processes.* In front, these joint with the palate bones. Behind, they present the *pterygoid fossa* and notch, by which each process is divided into two plates, the internal and external. The internal is longer; at its end is the *hamulus*, a hook-like process over which runs the tendon of the circumflexus palati muscle. The internal pterygoid muscle originates upon this internal plate. The external pterygoid muscle has its origin in the external plate of the pterygoid process, which is broader than the internal. Through the base of the process goes the *pterygoid foramen;* which conveys the Vidian or recurrent nerve, a branch of the fifth.

The sphenoid bone articulates with each of the other bones of the cranium, with the palate and vomer of the face, and with the malar.

Ethmoid Bone.

A light, cellular bone, at the base of the skull, below the frontal and in front of the sphenoid bone. Its general shape is cuboid.

Above, it presents the *cribriform plate*, through the orifices of

which pass the filaments of the first or olfactory nerve; through the anterior and largest foramen goes the internal nasal branch. The *crista galli* is an upright process or crest from the middle line of the cribriform plate. The falx cerebri is attached to it. In front, it joins the frontal bone. The *foramen cæcum* is here formed, between the two bones; it transmits a small vein.

Fig. 9.

UPPER AND POSTERIOR VIEW OF THE ETHMOID BONE.—1. Nasal lamella. 2. Body or cellular portion. 3. Crista galli. 4. Cribriform plate. 5. Superior meatus. 6. Superior turbinated bone. 7. Middle turbinated bone. 8. Os planum. 9. Surface for the olfactory nerve.

The *perpendicular plate*, or *nasal lamella*, descends from the middle of the cribriform plate, and constitutes part of the septum of the nose. It articulates with the vomer below.

Each outer surface of the ethmoid is called *os planum*. It forms part of the orbit of the eye, and joins above with the frontal bone, below with the superior maxillary and palate bones, in front with the lachrymal, and behind with the sphenoid. It has two foramina above, one of which transmits the internal nasal nerve. Below each os planum projects downwards and backwards the irregular *unciform* or hook-like process; which joins with the inferior turbinated bone.

The *superior* and *middle turbinated* bones are curved or scroll-like processes within the ethmoid, seen best from behind. They are attached to the inside of the lateral masses of the bone. The anterior cavities of the nose are thus formed and subdivided. The fissure between the superior and middle turbinated bones is the *superior meatus* of the nose. That beneath the middle, between it and the inferior turbinated bone, is the *middle meatus*. Into the latter empty the anterior ethmoidal cells; and, through them, the frontal sinuses. Into the superior meatus empty the sphenoidal sinus and the posterior ethmoidal cells.

The *pyramids of Wistar*, or of Bertin, are hollow, three-sided processes, the bases of which are attached to the superior turbinated bones, the cribriform plate and the nasal lamella, posteriorly. The apices, or points of the pyramids, lie one on each side of the azygos process of the sphenoid. These pyramids are connected with the ethmoid bone only during childhood; afterwards they form the walls of the sphenoidal sinuses.

Besides the frontal and sphenoid, the ethmoid bone articulates with eleven of the facial bones.

BONES OF THE FACE.

These are fourteen in number, all belonging to the superior maxillary region, except the single bone of the lower jaw. They are the two upper jaw bones, two nasal bones, two palate bones,

two malar bones, two ossa ungues, or lachrymal bones, two inferior turbinated bones, the lower jaw bone, and the vomer.

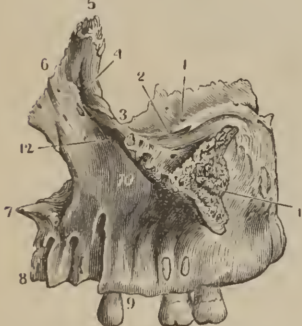
The Malar Bones.

Quadrangular and prominent, these form the cheek bones. Each has an outer and inner *surface*, four *processes*, the frontal, orbital, maxillary and zygomatic, and four *edges*, superior, inferior, anterior, and exterior. The outer surface is convex, the inner concave; each has small foramina for vessels and nerves. To the inner, the temporal and masseter muscles are attached; to the outer, the two zygomatic muscles. The *frontal* process joins with the frontal bone. The *orbital* process passes backwards to form part of the outer wall of the orbit; joining the greater wing of the sphenoid. The spheno-maxillary fissure, or foramen lacerum inferius, is bounded by an edge of the orbital process. The *maxillary* process articulates with the malar process of the upper jaw bone. The *temporal* process passes backwards to join the zygomatic process of the temporal bone in forming the zygomatic arch. To the posterior *edge* of the malar bone the temporal fascia is attached.

Two Superior Maxillary Bones.

Each is irregular in shape, with four *surfaces*, four *processes*, and a large cavity within the body. Each forms part of the floor of the orbit, the roof of the mouth, and the floor and outer wall of the nose. The *external* is the *facial* surface. Above the depression called the *canine fossa*, and near the upper edge of the facial surface, is the *infra-orbital foramen;* through which pass the infra-orbital artery, vein, and nerve.

Fig. 10.



SUPERIOR MAXILLA.—1. Orbitar process. 2. Infra-orbitar canal. 3. Space for the os unguis. 4. Upper part of the lachrymal canal. 5. Nasal process, and surface for articulating with the os frontis. 6. Surface for the nasal bone. 7. Anterior portion of the floor of the nostril. 8. Surface for articulating with its fellow. 9. Alveolar process. 10. Points to the depression just below the infra-orbitar foramen. 11. Surface for the malar bone.

The *posterior* surface is convex; its greatest prominence is below, the *maxillary tuberosity;* within, this joins with the palate bone. The posterior dental artery, vein, and nerve go through its foramina.

The *orbital* surface is superior; it is three-sided. The *nasal* or internal surface presents the opening into the *antrum Highmorianum*, or maxillary sinus. The junction of the ethmoid, palate, and inferior turbinated bones narrows this opening very much. The *cavity* is somewhat pyramidal in shape; its base being the outer wall of the nose.

The *malar process* is triangular and rough, for union with the malar bone. The *nasal* process rises to form part of the side of the nose. It joins with the nasal bone in front, the frontal bone above, and, behind, having a groove in common for the lachrymal sac, with the os unguis.

The *alveolar* process is thick and spongy ; it contains sockets for eight teeth, incisor, canine, and molar.

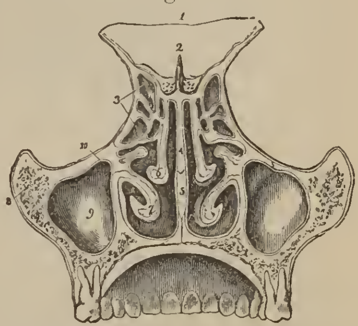
The *palate* processes make the roof of the mouth. From the median junction of the two arises the *nasal crest;* which articulates with the vomer. The *nasal spine* is at the front of this. Just behind it is the *foramen incisivum;* in which are the ganglion of Cloquet and the naso-palatine nerve.

Posteriorly, the palate processes unite with the horizontal plates of the palate bones.

Two Nasal Bones.

These are long and irregularly four-sided ; thick and narrow above, where they join the frontal bone ; thin and wide below, for the attachment of the cartilages of the nose. Externally, they are inclosed by the nasal processes of the two superior maxillary bones ; internally, they articulate with each other. The posterior surface has a groove for the internal nasal nerve. The inner border has a crest for junction with the nasal spine of the frontal above, and with the perpendicular plate of the ethmoid below.

Fig. 11.



THE NASAL CAVITIES.—1. Part of cranium. 2. Crest of ethmoid. 3. Ethmoid bone. 4. Middle of ethmoid. 5. Vomer. 6. Middle turbinated bone. 7. Inferior turbinated bone. 8. Malar bone. 9. Antrum.

Two Lachrymal Bones.

Also called *ossa ungues*, from resemblance to finger-nails. They are located at the front part of the inner wall of the orbit. A vertical ridge divides the orbital surface of each into two portions. In front is the ungual part of the lachrymal groove, completed by the nasal process of the superior maxillary. In the upper part of this groove lies the lachrymal sac ; in the lower, the nasal duct. The ridge gives origin to the *tensor tarsi*, or Horner's muscle.

The lachrymal bones articulate with the frontal, ethmoid, superior maxillary, and inferior turbinated bones.

Two Palate Bones.

Irregular ; formed chiefly in two portions. The *horizontal plate* on each side completes the roof of the mouth and palate, by junction with the palate processes of the upper jaw bone. Part of the

nasal crest which articulates with the vomer is formed at the junction of the two plates. Behind, in the same line, is the *posterior nasal spine.* From this the azygos uvulæ muscle arises.

The *vertical* plate articulates internally, by a ridge, with the inferior turbinated bone; externally, with the superior maxillary. In the latter articulation is the *posterior palatine foramen*, for the palatine artery and nerve.

Fig. 12.

THE PALATE BONE.—1. Palate plate on its nasal suface. 2. Nasal plate. 3. Pterygoid process. 4. Surface for articulating with its fellow. 5. Half of the crescentic edge and spine for the azygos uvulæ muscle. 6. Ridge for the inferior spongy bone. 7. Spheno-palatine foramen. 8. Orbital plate.

The *pterygoid process* is behind and below. It is triangular, and receives the two plates of the pterygoid process of the sphenoid bone.

The *spheno-palatine foramen* is formed by a notch between the processes at the upper part of the vertical plate being completed by junction with the sphenoid bone. Through this foramen pass the spheno-palatine artery and nerve.

Anteriorly, and above, is the *orbitar* process, which passes between the superior maxillary and the ethmoid, to contribute a small portion to the orbit of the eye. The other process passes backwards, at the top of the vertical plate; it is called the pterygoid apophysis, and joins the sphenoid bone.

Vomer.

The posterior nares are divided by this bone; which is flat, thin, and vertical in position, with its antero-posterior diameter the longest. Its upper border is thickest, and articulates with the sphenoid. Its anterior border joins in front with the triangular cartilage of the nose, and, behind this, with the ethmoid. The inferior border articulates in front with the superior maxillary bones, and further with the palate bones. The posterior border is concave, thin-edged, and free.

Two Inferior Turbinated Bones.

Small, spongy, *scroll-shaped*, one on each side of the nose, within the fossa, attached to its outer wall. The internal convex surface of each is covered by the lining membrane of the nose; its external surface is concave, and forms part of the inferior meatus. Each bone articulates with the ethmoid, superior maxillary, palate, and lachrymal bones. (See fig. 13.)

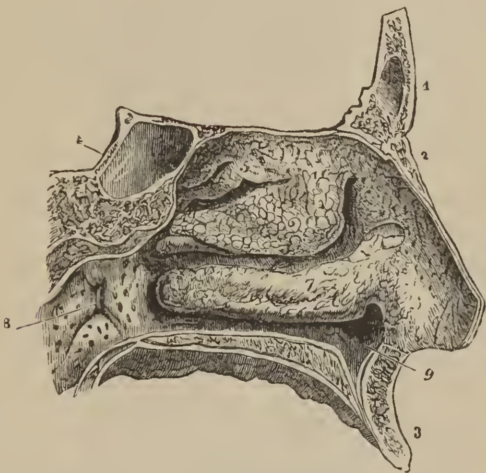
Inferior Maxillary Bone.

This consists of the *body*, horizontal and convex anteriorly, and two perpendicular *rami*.

In the median line of the body is the ridge of the *symphysis*, where join the two parts in which the bone is developed. At the base of this ridge is the triangular *mental process.* Each side of the

symphysis is the *incisive fossa;* outside of this, the *mental foramen,* through which pass the mental artery and nerve. The internal surface is marked by the *four genial tubercles*, for muscular insertions. Near them are fossæ for the sublingual glands.

Fig. 13.



LEFT NASAL FOSSA.—1. Frontal bone. 2. Nasal bone. 3. Superior maxillary. 4. Sphenoid. 5, 6, 7. Superior, middle, and inferior turbinated bones.

The *superior border* is hollowed out for the sockets of sixteen teeth, in the adult.

Each *ramus* is four-sided, with two prominent processes above. Its flat external surface is covered by the masseter muscle. Its *internal surface* has the aperture of the *inferior dental canal*, for the nerve and vessels of the same name. This canal passes into the substance of the body of the bone, to distribute nerves and vascular branches.

The *condyloid process* is short and thick, with a condyle for articulating with the temporal bone, and below this, a neck.

The *coronoid process* is flat, thin, and triangular; anterior to the condyloid, with the *sigmoid notch* between them. It is the point of attachment of the temporal muscle.

General Remarks on the Head.

The Sutures.—These are the somewhat irregular and generally serrated lines of articulation of the bones of the head. The principal are the *coronal*, *sagittal*, *squamous*, and *lambdoidal* sutures.

The *coronal* suture is between the frontal and the two parietal bones, across the head above.

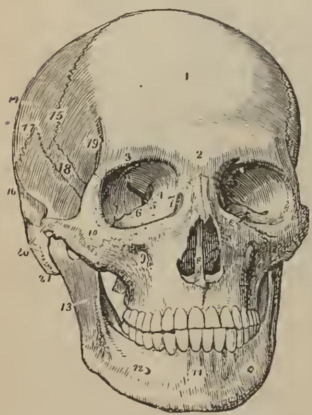
The *sagittal* suture is between the two parietals, passing longitudinally.

The *squamous* suture connects the temporal with the parietal and sphenoid bones. It is rough and undulated rather than serrated.

The *lambdoidal* suture (named for the Greek letter lambda) is between the parietal bones and the occiput. It is formed of two limbs separating at an angle.

Diploë.—This is the cellular bony structure between the outer and the inner tables of the skull. Branching canals through it contain veins. The outer table of the bones of the skull is the strongest and least brittle. In infancy they are closely connected, with but little diploë.

Fig. 14.



FRONT VIEW OF THE SKULL.—1. Os frontis. 2. Nasal tuberosity. 3. Supra-orbital ridge. 4. Optic foramen. 5. Sphenoidal fissure. 6. Spheno-maxillary fissure. 7. Lachrymal fossa. 8. Opening of the anterior nares, and the vomer. 9. Infra-orbital foramen. 10. Malar bone. 11. Symphysis of the lower jaw. 12. Anterior mental foramen. 13. Ramus of the lower jaw-bone. 14. Parietal bone. 15. Coronal suture. 16. Temporal bone. 17. Squamous suture. 18. Great wing of the sphenoid.

Exterior Regions of the Head.—These are the coronal region, the facial, the two lateral, and the basal region.

The *coronal* region is seen in a vertical view of the cranium in its natural position.

The *facial* region is bounded by the parietal protuberances, the zygomatic arches, the coronal suture, and the margin of the lower jaw.

The *lateral* regions are contained between the temporal ridge above, the margin of the orbit in front, and the lambdoidal suture behind.

The *base of the skull* is very irregular and complex; capable of being studied to advantage only with a specimen or plate. Its general outline is oval. Its principal foramina are, the *foramen magnum occipitis*, *foramen incisivum*, *posterior palatine foramen*, *foramen lacerum anterius*, *foramen lacerum posterius*, and the special foramina of the sphenoid bone.

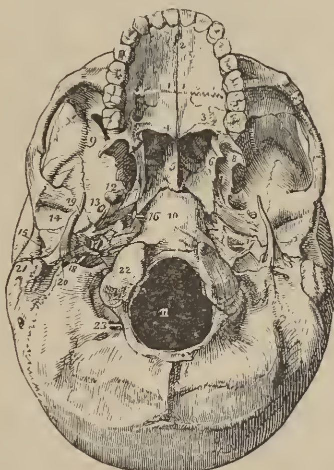
Interior Regions of the Cranium.—The *calvaria*, or vaulted roof of skull, is generally smooth within, though marked for the convolutions of the brain, and also by a groove for the longitudinal sinus of the dura mater, and depressions, on each side of the sagittal suture, for the *glands of Pacchioni.*

The *base of the cranium*, within, exhibits three regions, *anterior*, *middle*, and *posterior*. The anterior fossa lodges the anterior lobes of the cerebrum; the middle fossa the middle lobes of the same; while the pons Varolii, medulla oblongata, and cerebellum are contained in the posterior fossa.

The Orbit.—The cavity for the eye is a somewhat quadrangular pyramid, formed of seven bones; the frontal, superior maxillary, malar, sphenoid, ethmoid, palate, and lachrymal bones.

Nasal Cavities. (See fig. 11.)—These are contained between the cribriform plate of the ethmoid and the sphenoid bones above; in front, the ossa nasi and cartilages of the nose; below, the palate processes of the superior maxillary and palate bones; outside, the superior maxillary, ethmoid, and inferior turbinated bones. Between the two cavities is the *septum narium*, formed by the vomer, nasal lamella of the ethmoid, and the nasal cartilage.

Fig. 15.



EXTERNAL VIEW OF THE BASE OF THE CRANIUM.—1. Hard palate. 2. Foramen incisivum. 3. Palate plate of palate bone. 4. Crescentic edge. 5. Vomer. 6. Internal pterygoid process of sphenoid bone. 7. Pterygoid fossa. 8. External pterygoid process. 9. Temporal fossa. 10. Basilar process. 11. Foramen magnum. 12. Foramen ovale. 13. Foramen spinale. 14. Glenoid fossa. 15. Meatus auditorius externus. 16. Foramen lacerum anterius. 17. Carotid foramen. 18. Foramen lacerum posterius. 19. Styloid process. 20. Stylo-mastoid foramen. 21. Mastoid process. 22. Condyles of occipital bone. 23. Posterior condyloid foramen.

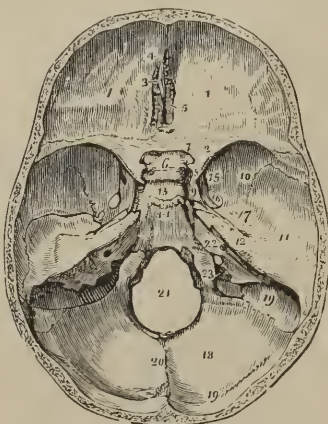
The outlets from these fossæ in front are the *anterior nares;* behind, the *posterior nares.* The passages, nearly horizontal, through the nasal cavities are, the *superior*, *middle*, and *inferior meatus.* The superior is the smallest. The middle contains the opening into the *antrum maxillare.* The inferior presents the orifice of the *ductus ad nasum* from the lachrymal sac.

Ossa Triquetra, or Wormiana.—These are small, irregular bones, not always present or of the same shape, included in the sutures, especially the lambdoidal.

Fontanelles.—These, most interesting in obstetric anatomy, are places of deficient ossification at the junction of the bones in the head at and for a time after birth. They are the *anterior* and *posterior* fontanelles, and two smaller ones on each side.

Diameters of the Head.—In the adult of European race, the cranium is about six inches and a half in length, five inches in height, and five and a half transversely.

Fig. 16.



INTERNAL SURFACE OF THE BASE OF THE CRANIUM.—1. Anterior fossa for anterior lobes of the cerebrum. 2. Lesser wing of the sphenoid bone. 3. Crista galli. 4. Foramen cæcum. 5. Cribriform plate. 6. Processus olivaris. 7. Foramen opticum. 8. Anterior clinoid process. 9. Groove for the carotid artery. 10. Greater wing of the sphenoid bone. 11. Middle fossa for middle lobes of the cerebrum. 12. Petrous portion of temporal bone. 13. Sella turcica. 14. Basilar gutter for the medulla oblongata. 15. Foramen rotundum. 16. Foramen ovale. 17. Foramen spinale. 18. Posterior fossa for the cerebellum. 19. Groove for the lateral sinus. 20 Ridge for the falx cerebelli. 21. Foramen magnum. 22. Meatus auditorius internus. 23. Posterior foramen lacerum for the jugular vein.

Internal Capacity.—Morton gives, as the average capacity of the Anglo-Saxon and German cranium, ninety cubic inches; of the native African races, eighty-five inches; other races coming between.

Form of the Head.—Dividing the human species into five *varieties*, the head in the *Caucasian* or *European* may be described as of a rounded or oval shape. In the *Mongolian* race it is pyramidal, rising from the prominent cheek bones and almost vertical occiput toward the sagittal suture. In the *Malay* the same shape of the head is seen, with a broader and flatter face. The head of the *American* Indian is also like that of the Mongolian, with some-

what greater prominence of the face. The *Negro* has a skull long antero-posteriorly, with low forehead, full occiput, and prominent maxilla.

Facial Angle.—After Camper, this is obtained by drawing a line from the anterior margin of the upper jaw to the most prominent part of the forehead, and crossing this by a horizontal line from the external meatus of the ear to the lower edge of the nose. Morton asserts the mean facial angle of the Caucasian race to be 80°; of the Mongolian, 77°; of the Malay, American Indian, and Negro, 75°. All that the facial angle determines is the proportion of development between the head and face.

HYOID BONE.

Connected in man with no other bone, the os hyoides is attached to the root of the tongue and the larynx. It is shaped like the letter U, or a horse-shoe, the convexity being forward. Besides the central body, it has two greater and two lesser *cornua*. The *greater* project backwards, each terminating in a tubercle. The *lesser* cornua ascend, to the length of a few lines, from the junction of the body and the greater cornua; they are generally cartilaginous. Several muscles and ligaments are connected with this bone.

THE THORAX.

The *sternum*, *ribs*, and *dorsal vertebræ* inclose the chest. Its shape is that of an imperfect cone, notched in front, below, and flat above, concave behind, and open at the top.

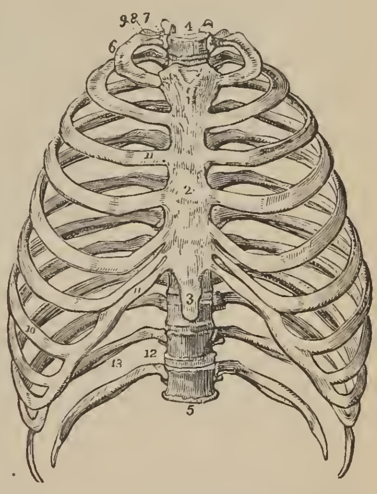
Sternum.

Composed of three pieces, this bone is flat and oblong. In old age the pieces are consolidated into one.

The first or upper piece is the thickest. The clavicle on each side articulates with it at its upper corner; lower down are small cavities for the first rib and part of the second.

The *second* or middle piece is the longest, but is

Fig. 17.



FRONT VIEW OF THE THORAX.—1. First bone of the sternum. 2. Second bone of the sternum. 3. Third bone or ensiform cartilage. 4. First dorsal vertebra. 5. Last or twelfth dorsal vertebra. 6. First rib. 7. Its head. 8. Its neck. 9. Its tubercle. 10. Seventh or last true rib. 11. Its cartilage. 12. Angle of eleventh rib. 13. Its body.

narrower than the first, though widening below. With its sides articulate the cartilages of part of the second rib, the whole of the third, fourth, fifth, sixth, and part of the seventh.

The *third* piece is often a cartilage only. It varies much in shape, being sometimes bifurcated. It is often called the xyphoid or ensiform cartilage. Part of the cartilage of the seventh rib is attached to its side.

Ribs.

Twelve on each side; *seven* whose cartilages reach the sternum, called *true* ribs, and *five* others below, the *false* ribs. The last two, with free ends, are called *floating* ribs.

The sternal end of each rib is larger than the vertebral end. The latter is rounded, with a ridge dividing it into two surfaces. Beyond this round head is a neck, and an inch from the head is a tubercle, which articulates with the transverse process of a vertebra. A smaller tubercle receives the *external costo-transverse ligament.* The *internal* costo-transverse ligament is inserted into the upper edge of the neck of the rib.

Besides a twist in its whole shape, each rib has an *angle*, as though it had been bent. Along its rounded upper *edge* the intercostal muscles are inserted. Within the thin and cutting lower edge, for two-thirds of its length, is a groove for the intercostal nerve and vessels.

The *first* rib is the smallest and most simple in form. The subclavian artery rests in a fossa on its upper surface; to which are attached the scalenus anticus and scalenus medius muscles. This rib has no intercostal groove.

The longest rib is the eighth; after that they decrease to the last; which also is without an intercostal groove.

THE PELVIS.

Two *ossa innominata*, the *sacrum*, and the *coccyx* inclose this cavity.

OSSA INNOMINATA.

Large, irregular, 8-shaped bones, one on each side, known as the hip-bones. Until puberty each innominatum consists of three bones united; the *ilium*, *pubes*, and *ischium.*

Ilium.

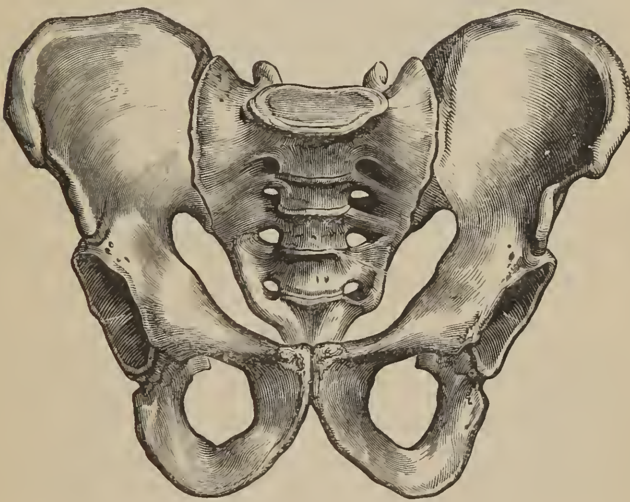
A very large, flat or concavo-convex bone, the uppermost of the pelvis. Its outer surface or *dorsum* is smooth in the main, and bounded above by the *crest*, below by the *acetabulum*, before and behind by the anterior and posterior *borders*. Three semicircular lines cross the dorsum ilii. Between the upper and the crest originates the gluteus maximus muscle. Between the upper and middle curved lines the gluteus medius arises. The space between the middle and lower lines gives origin to the gluteus minimus.

Of the internal surface, the anterior or larger part, the *venter*, or

iliac fossa, is smooth; the iliacus internus muscle lodges upon it. Behind this fossa is a rough surface; the upper part of which has attached to it the posterior sacro-iliac ligaments, and the lower part articulates with the side of the sacrum.

The *crest* of the ilium is a convex, thick, curved line; thickest behind. In front it ends in the anterior superior spinous process; behind, in the posterior superior spinous process. To the outer edge of the crest are attached the tensor vaginæ femoris, obliquus externus, and latissimus dorsi muscles; to the inner edge the transversalis abdominis, and two other muscles; between the two edges the obliquus internus.

Fig. 18.



ANTERIOR VIEW OF THE MALE PELVIS.

The *anterior superior spinous process* of the ilium gives origin to the tensor vaginæ femoris, sartorius, and iliacus internus muscles, and attachment to the fascia lata and Poupart's ligament. Just beneath the process is a notch, ending in the anterior inferior spinous process. To this is attached the straight tendon of the rectus femoris muscle.

On the posterior border of the ilium, separated by a notch, are the posterior superior and posterior inferior spinous processes. The great *sacro-sciatic notch* is below the inferior process.

Pubes.

This forms the anterior part of the innominatum. It consists of a horizontal *body* and a descending *ramus*.

The outer extremity of the body is the thickest, and constitutes

one-fifth of the acetabulum. At the inner extremity is the *symphysis pubis*.

The upper surface of the body of the pubes presents its *spine*, and, going backward from this, a ridge called the *linea ilio-pectinea.* To this line parts of Poupart's and Hey's ligaments are attached. The under surface of the body has a sharp margin for the upper part of the circumference of the thyroid or obturator foramen.

The *ramus* of the pubes goes outwards and downwards to join the ramus of the ischium. Its outer border forms part of the margin of the thyroid foramen. The crus penis in the male is attached to its inner border.

Ischium.

Situated beneath the ilium, and behind and below the pubes, this bone is at the lowest part of the innominatum. It has a *body* and a *ramus*. Of the body, the smooth inner surface is called the *plane* of the ischium. At its posterior part is the *spine* of the ischium; to which is attached the lesser sacro-sciatic ligament. Lower than this is the *tuberosity* of the ischium, on which we sit. It gives origin to the semi-tendinosus and semi-membranosus muscles, and the long head of the biceps flexor cruris. The great sacro-sciatic ligament is attached to a ridge in front of this. The *ramus* of the ischium ascends to join that of the pubes. Below, its inner surface gives a sharp border to form part of the margin of the obturator foramen.

Acetabulum.

The *acetabulum* or *cotyloid cavity*, the socket for the thigh bone, is a deep hemispherical depression, formed in its upper two-fifths by the ilium, internal one-fifth by the pubes, and lower and posterior two-fifths by the ischium. Its rim is prominent but uneven. On the inner side is the deep *cotyloid notch;* at the end of which is a circular *depression* at the bottom of the cavity, in which lodges a mass of fat, and around which arises the ligamentum teres.

Thyroid Foramen.

The *thyroid* or *obturator foramen*, oval in the male, triangular in the female, is a large opening, bounded by the pubes and ischium. Except a groove above for the obturator nerve and vessels, it is filled by a membranous ligament.

The sacrum and coccyx have been described with the spine.

UPPER EXTREMITY.

SHOULDER.

Two bones in man form the shoulder; the scapula or shoulder-blade, and the clavicle or collar-bone.

Scapula.

A thin, flat, three-sided bone, reaching downward from the second to the seventh rib, behind the thorax on each side.

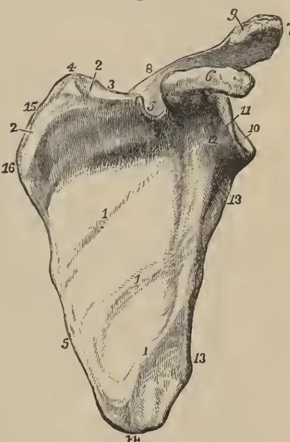
The *venter* or *costa* of the scapula is the concave face which presents anteriorly towards the ribs, and is occupied by the subscapularis muscle. The *dorsum* or posterior surface is unequally divided by the *spine* of the scapula. In the smaller space or fossa above the spine arises the supra-spinatus muscle; in the larger space below it, the infra-spinatus.

The *acromion* process is at the outer extremity of the spine. In front, this process articulates with the clavicle.

Part of the deltoid muscle arises from the edge of the spine of the scapula; and the trapezius muscle is inserted into it.

At the *external angle* of the scapula is a process hollowed out for the *glenoid cavity* of the shoulder-joint. This is a shallow socket of an oval shape. At its top is a mark for the origin of the long head of the biceps muscle. The glenoid process has a narrow *neck*; from this, forwards and outwards, extends the *coracoid process* of the scapula. Its name is given (from *corax*, a crow) from its shape resembling a crow's beak. From its end originate the coraco-brachialis muscle and the short head of the biceps. The pectoralis minor muscle is inserted into it.

Fig. 19.



Venter of Scapula.—1, 1, 1. Oblique ridges. 2, 2. Fossa for subscapularis muscle. 3. Superior border. 4. Superior angle. 5. Suprascapular notch. 6. Coracoid process. 7. Acromion process. 8. Spine of scapula. 9. Articular surface. 10. Glenoid cavity. 11. Head of scapula. 12. Neck. 13. Inferior border. 14. Inferior angle. 15. Posterior border. 16. Origin of spine.

The *superior angle* of the scapula is almost a right angle; into it is inserted the levator scapulæ muscle. The *superior edge* is thin; the *coracoid notch* divides it; this notch, made a foramen by a ligament, transmits the supra-scapular nerve and artery.

The *inferior angle* is pointed. The teres major muscle arises from its posterior surface.

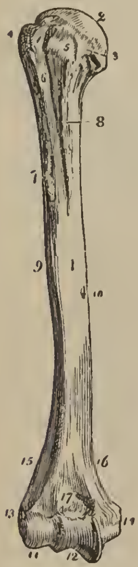
Clavicle.

A long, transverse, *f*-shaped bone, extending from the upper part of the sternum to the scapula. The two-thirds nearest the sternum are convex in front; the humeral third is concave in front. Near the sternal end, inferiorly, is a roughness for the attachment of the costo-clavicular ligament; next to this the subclavius muscle

is inserted; and near the humeral end is attached the coraco-clavicular ligament, to a ridge and tubercle. The pectoralis major muscle arises in part from the anterior edge of the clavicle.

The sternal end of this bone is the thickest, and is elongated behind and below. The humeral end has a face for articulation with the acromion process of the scapula.

Fig. 20.



ANTERIOR VIEW OF HUMERUS OF THE RIGHT SIDE.—1. Shaft or diaphysis. 2. The head. 3. Anatomical neck. 4. Greater tuberosity. 5. Lesser tuberosity. 6. The bicipital groove. 7. External bicipital ridge for pectoralis major. 8. Internal bicipital ridge. 9. Point of insertion of deltoid muscle. 10. Nutritious foramen. 11. Face for head of the radius. 12. Face for the ulna.

ARM.

The *arm* consists of a single bone; the humerus.

Humerus.

This long, cylindrical bone consists of a round *head*, an ill-defined *neck*, a *shaft*, and two *condyles*. The head is hemispherical, and fits into or against the glenoid cavity of the scapula. The *anatomical* neck of the bone is a *groove*, just beyond the articulation. A *greater external*, and a *lesser internal tuberosity* are below this neck, with a perpendicular groove between them for the tendon of the long head of the biceps muscle. Into the greater tuberosity are inserted the supra-spinatus, infra-spinatus, and teres minor muscles; into the lesser tuberosity, the sub-scapularis. The pectoralis major, teres major, and latissimus dorsi muscles are inserted into the humerus below its head, near the edges of the bicipital groove. Between the anatomical neck and these insertions is the so-called *surgical* neck of the bone.

The deltoid muscle is inserted on the outer side of the middle of the humerus. The coraco-brachialis is attached on its inner side. The *nutritious foramen* is a little lower; and above this a spiral groove, occupied by the profunda major artery and the muscular spiral nerve.

The humerus flattens below, and widens, having a ridge on each side extending to the *internal* and *external condyles*. Of these the internal is the most prominent. Anteriorly, the lower extremity of the bone presents the *lesser sigmoid cavity*, for the coronoid process of the ulna. Posteriorly is found the *greater sigmoid cavity*, for the olecranon process.

FOREARM.

The *forearm* contains two bones; the *radius*, on the side with the thumb, and the *ulna*, on the side of the little finger.

Radius.

Small above, where it contributes but little to the elbow-joint; larger below, for firm union with the wrist. The upper end presents a rounded head, having a shallow depression which meets a slight projection of the end of the humerus. Below this is a distinct neck, embraced by a ligament within which it turns. Internally, below this neck, is a tubercle for the biceps tendon.

The outer surface of the radius is curved. The thick inferior end articulates with the scaphoid and lunar bones of the wrist, as well as, laterally, with the ulna. The *styloid process* of the radius is below, on the outside; to it is attached the external lateral ligament.

Three grooves on the back of the lower part of the radius transmit the tendons of the extensor muscles to the hand. The extensor major pollicis has the deepest mark.

Several muscles arise from the radius, which will be hereafter described.

Fig. 21.

ANTERIOR VIEW OF RADIUS OF RIGHT SIDE.—1. Cylindrical head. 2. Surface for lesser sigmoid cavity of the ulna. 3 Neck of the radius. 4. Its tubercle, for insertion of biceps muscle. 5. Interosseous ridge. 6. Concavity for lower end of the ulna. 7. Carpal surface. 8. Styloid process. 9. Surface for pronator quadratus muscle.

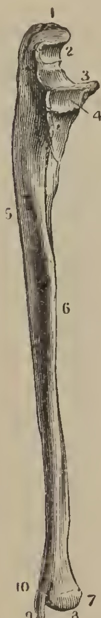
Ulna.

This is longer than the radius, and upon its inner side in the skeleton. It is largest at its upper end. Behind the elbow-joint, it ascends in the *olecranon process*. Into this the tendon of the *triceps extensor cubiti* muscle is inserted. In front is the *coronoid* process; into which is inserted the *brachialis anticus* muscle. The *greater sigmoid cavity* lies between these two processes; it receives the end of the humerus. The *lesser* sigmoid cavity is outside of the coronoid process, and receives the head of the radius. The anconeus muscle is inserted behind it; and the supinator radii brevis arises from a ridge near it.

The upper three-fourths of the anterior face of the ulna give origin to the flexor profundus digitorum muscle. Below this, lies the pronator quadratus muscle. Posteriorly, the ulna gives origin to the extensores pollicis and indicator muscles. To its outer edge the interosseous ligament is attached.

At its lower end the ulna is round, with a smooth surface for the radius, on its outside. From the inner side goes off the styloid process, to which the internal lateral ligament is attached. Behind the process is a groove for the extensor carpi ulnaris tendon.

Fig. 22.

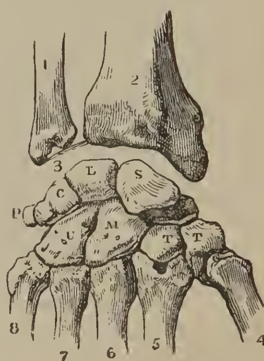


ANTERIOR VIEW OF ULNA OF THE LEFT SIDE.—1. Olecranon process. 2. Greater sigmoid cavity. 3. Coronoid process. 4. Lesser sigmoid cavity. 5. External surface. 6. Ridge for interosseous ligament. 7. Small head for the radius. 8. Carpal surface.

CARPUS.

The carpus or wrist consists of eight bones, in two rows. The wrist is convex posteriorly, concave anteriorly; through the concavity pass the flexor tendons.

Fig. 23.



ARTICULATIONS OF BONES OF THE CARPUS.—1. Ulna. 2. Radius. 3. Inter-articular fibro-cartilage. 4. Metacarpal of thumb. 5. Metacarpal of first finger. 6. Metacarpal of second finger. 7. Metacarpal of third finger. 8. Metacarpal of fourth finger. S. Scaphoid. L. Lunar. C. Cuneiform. P. Pisiform. T, T. Trapezium and trapezoid. M. Magnum. U. Unciform.

The upper row of bones contains the *scaphoid*, *lunar*, *cuneiform*, and *pisiform*. The lower row has the *trapezium*, *trapezoid*, *magnum*, and *unciform*.

The *scaphoid*, or boat-shaped bone, is on the radial side of the upper row. Above, it is convex, to articulate with the end of the radius; below, concave for the magnum. It also articulates with the lunar, trapezium, and trapezoid.

The *lunare*, *lunar*, or crescent-shaped bone, has a convex upper surface, which joins the radius, and articulates below with the magnum, and at the side with the cuneiform.

The *cuneiform*, or wedge-shaped bone, is joined below to the unciform, and at the side to the pisiform. It has a round face to meet the latter bone.

The *pisiform*, or pea-shaped bone, is the smallest of the carpus. It unites only with the cuneiform. It forms a prominence on the palmar face of the wrist, at the ulnar side.

The *trapezium* is many-sided. It articulates with the trapezoid, the scaphoid, and the metacarpal of the thumb.

The *trapezoid* is smallest of the lower row; it has a pyramidal shape, the apex being on the palmar side.

The *magnum* is the largest bone of the carpus. It is four-sided, with a rounded head or tubercle on its dorsal surface.

The *unciform* is remarkable especially for a hooked process on the palmar side.

METACARPAL BONES.

These are five, one for each digit. Each metacarpal has a round *head*, to join with the first phalanx below; a rough four-sided *base* above, for its carpal articulation; and a prismatic *shaft*, on the sides of which the interossei muscles are attached.

The longest metacarpal is that of the index or fore-finger. That of the thumb is short and thick. The smallest is that of the little finger.

FINGERS.

Each finger has a *first*, *second*, and *third* phalanx; counting from the metacarpal bone. The thumb has but two phalanges. The first phalanx is always the largest, and is convex on its dorsal surface, flat on the palmar side. A concavity at its upper end receives the round head of the metacarpal bone. Below it presents to the end of the second phalanx two small tuberosities with a groove between them.

The second phalanx has at its upper end two concavities with a ridge between them; at its upper end two tubercles with an intermediate groove, to meet the third.

The third phalanx is smallest. Its upper end resembles that of the second; its lower extremity is thin, rough, and flat.

The fore-finger is called the *index*. The middle and longest finger has been sometimes named the *impudicus;* the third, *annularis;* the little finger, *auricularis*.

Sesamoid Bones.—Two of these (named from *sesamum*, oriental barley) are usually in the metacarpo-phalangeal joint of each thumb, connected with the flexor tendon. They are not unfrequently wanting.

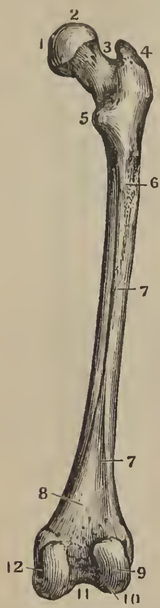
LOWER EXTREMITY.

Femur.

This, the thigh bone, is the longest of all the bones. It has a *head*, *neck*, *shaft*, and *condyles*.

The *head* is nearly spherical, to be received into the acetabulum. Near its middle, above, is a depression for the ligamentum teres. The *neck* shortens and approaches a right angle in its direction in old age, when it is more liable to fracture. Outside, at the lower end of the neck, is the large process called the *trochanter major.* The gluteus medius, gluteus minimus, and other muscles are inserted into this.

Fig. 24.



Posterior View of the Femur.—1. Depression for round ligament. 2. The head. 3 Depression for rotary muscles. 4. Trochanter major. 5. Trochanter minor. 6. Roughness for gluteus maximus tendon. 7, 7. Linea aspera. 8 Surface for gastrocnemius muscle. 9. External condyle. 10 Depression for anterior crucial ligament 11 Depression for posterior crucial ligament. 12 Origin of internal lateral ligament.

The *trochanter minor* is lower and more internal; the iliacus internus and psoas magnus muscles are inserted into it. Into a ridge between the trochanters behind is inserted the quadratus femoris.

The *shaft* of the femur is arched, the convexity being in front. Over its anterior surface is the origin of the cruræus muscle. The *linea aspera* is a strong ridge up and down the posterior surface of the bone. It has two edges; to the outer are attached the tendon of the gluteus maximus, and the muscular origin of the vastus externus and the short head of the biceps. Into the inner edge of the linea aspera are inserted the pectineus and adductor magnus; and from this edge arises the vastus internus.

The *condyles*, internal and external, are at the lower end of the femur, which widens towards them. The *external* condyle has upon its posterior face the origin of the popliteus, part of the gastrocnemius and plantaris muscles. The *internal* condyle is longest. It also gives part origin to the gastrocnemius. Each condyle has marks for the crucial and lateral ligaments.

The fossa in front of the condyles for the patella receives its largest contribution from the external condyle.

Patella.

A flat bone of a roundish triangular shape, commonly known as the cap of the knee or knee-pan. It is thickest and widest above, where the tendon of the quadriceps femoris is inserted into it. Below, the continuation of the same tendon, in which (like a sesamoid bone) the patella may be considered as situated, is called

the ligament of the patella ; this is inserted in the tibia. The knee-pan is covered anteriorly only by the skin.

Tibia.

The inner and larger of the two bones of the leg. Its *head*, or large upper end, presents an oval surface, divided by the upright *spinous process* into two parts, each oval, for the condyles of the femur. Projections on each side are called the external and internal condyles of the tibia. At the back part of the external condyle is a small face for the articulation of the fibula.

In front, below the head, is a tubercle for the tendon or ligament of the patella. Posteriorly, is the insertion of the popliteus muscle, and the origin of the soleus.

Of the *body*, the inner surface is covered only by skin. The outer surface is occupied by the tibialis anticus and extensor digitorum. The tibialis posticus and flexor digitorum arise from its posterior surface.

The outer *edge* of the tibia has attached to it the interosseous ligament. To the upper portion of the rounded inner edge are attached the tendons of the sartorius, semi-tendinosus, and gracilis muscles.

The lower end of the tibia is smaller than the upper. Internally, it presents the *internal malleolus* or large process of the ankle. Outside, it articulates, by a fossa, with the lower end of the fibula. Between these parts, at the end of the bone, is a concavity which rests and moves, by a hinge-like joint, upon the astragalus.

Fig. 25.

ANTERIOR VIEW OF THE TIBIA.—1. Spinous process. 2 Surface for condyles of the femur. 3. Face for head of the fibula. 4. The head. 5. The tubercle. 6, 6. Spine and shaft of the bone. 7. Internal malleolus. 8 Process for internal lateral ligament of the ankle. 9 Tarsal surface 10. Face for lower end of fibula.

The extensor tendons lie over the anterior surface of the lower end of the tibia ; the tendon of the flexor longus pollicis marks its posterior surface.

Fibula.

Much more slender than the tibia, this bone is external to it, and, above, somewhat behind it ; not reaching to the articulation of the knee. It supports the head of the tibia, having an enlargement or head to articulate with its outer condyle. The biceps flexor cruris is inserted into its *styloid process*.

The body of the fibula has three surfaces ; internal, external, and posterior. The internal or tibial surface presents a long ridge

Fig. 26.

THE FIBULA.—1. Head. 2 Articular face. 3. Insertion of external lateral ligament. 4. Shaft. 5, 5. External face. 6. Interosseous ridge. 7 Face for lower end of tibia. 8. Malleolus externus. 9 Tarsal surface.

for the interosseous ligament. The extensor communis and extensor proprius pollicis arise in front of this ridge; behind it, the tibialis posticus partly arises.

The wide external surface is a long spiral, anterior above, and becoming posterior below. The peroneus longus and peroneus brevis muscles arise from the upper portion of this surface, and their tendons pass through a groove on its lower part. On the posterior surface, which is somewhat spiral, arise the soleus and flexor longus pollicis muscles.

The *external malleolus* is a long descending process of the lower end of the fibula. It is somewhat triangular, with a pointed termination, the coronoid process, to which the external lateral ligament is attached. Within, the malleolar process articulates with the astragalus.

TARSUS.

Seven bones form the tarsus; the *astragalus*, *os calcis*, *scaphoid*, *cuboid*, and *internal*, *middle*, *and external cuneiform*.

Astragalus.—Composed of a *head* and a *body*. The *body* is rounded above for the tibial articulation; nearly flat at the sides, for the two malleoli; underneath, the body is concave. The anterior part or *head* is convex in front, and widest transversely. A constriction or neck intervenes between the head and the body.

Os Calcis.—This, the heel-bone, is the largest of the tarsus. It articulates above with the astragalus by two surfaces, having between them a groove for the interosseous ligament.

Externally the os calcis is covered by skin. The tendons of the peroneus longus and peroneus brevis mark the surface with grooves. On its internal surface is the *sinuosity*, occupied by tendons, nerves, and bloodvessels going to the plantar region of the foot.

Behind, the bone is rough below for the insertion of the tendo-Achillis; above, it is smooth. *Underneath*, the os calcis has three tuberosities, for ligaments and tendons.

In *front*, are the greater and lesser *apophyses*. The greater joins the cuboid bone. The lesser is hook-shaped, passing forward and ascending to meet the astragalus. The tendon of the flexor longus pollicis passes through a groove on its surface.

Scaphoid.—Thickest above, convex in front, concave behind. The anterior surface has three facets for the cuneiform bones. The astragalus fits into the posterior deep concavity. The tibialis pos-

ticus muscle is inserted into a tubercle on the inner face of this bone.

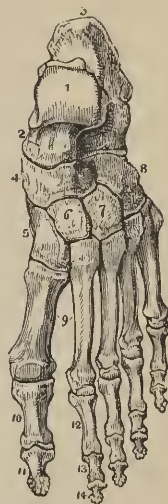
Cuboid.—Convex and rough above. Underneath, at the end of a ligamentous ridge, is a groove for the peroneus longus tendon. In front, the cuboid articulates with the last two metatarsals; behind, with the great apophysis of the heel bone; internally, with the external cuneiform.

Internal Cuneiform.—Largest of the three. The point of the wedge is uppermost. It is concave externally, convex internally, where it is covered by tegument only. Behind, it joins the scaphoid by a triangular surface; in front, it meets the metatarsal of the great toe. The tibialis anticus muscle is inserted into the inner side of the rounded base or lower part of the bone.

Middle Cuneiform.—Smallest of the three. The apex of the wedge is downwards. In front, it joins the second metatarsal, internally, with the internal cuneiform; externally, with the external cuneiform, and behind with the scaphoid.

External Cuneiform.—Size intermediate between the two others. The narrow part of the wedge is below. Its joints, in front, the third metatarsal; on its inner side, by two surfaces, the internal cuneiform and second metatarsal; behind, the scaphoid. Outside, it has a process which joins anteriorly with the fourth metatarsal bone, and posteriorly with the cuboid.

Fig. 27.



UPPER SURFACE OF THE LEFT FOOT.—1. Astragalus. 2. Its anterior face. 3. Os calcis. 4. Navicular, or scaphoid. 5. Internal cuneiform. 6. Middle cuneiform. 7 External cuneiform 8. Cuboid bone. 9, 9 Metatarsal bones. 10 First phalanx of the big toe. 11. Second phalanx of the big toe. 12, the first; 13, second; and 14, third phalanges of the other toes.

METATARSAL BONES.

Five in number, one for each toe. At their bases they articulate with the cuboid and cuneiform bones. By rounded heads they join the first phalanges of the toes.

The *first* metatarsal, on the inside, is the thickest and shortest. It articulates by a large base with the internal cuneiform. The peroneus longus tendon is inserted into it. Sesamoid bones are met with in its phalangeal articulation.

The *second* is the longest of all. It articulates with the middle cuneiform behind, internally with the internal cuneiform, externally with the external cuneiform and third metatarsal.

The *third* joins by its base with the external cuneiform, and, outside, by two facets, with the fourth metatarsal.

The *fourth* articulates with the cuboid, and, at its sides, with the third and fifth.

The *fifth* and smallest articulates with the cuboid and fourth metatarsal. From its base projects outwards and backwards a *tubercle*, which receives the tendons of the peroneus tertius and peroneus brevis muscles.

TOES.

Each has a *first*, *second*, and *third phalanx*, counting from the metatarsus, except the great toe, which has but two.

The *first* phalanx is always smaller than the first of the corresponding finger. Their bodies are narrow, their bases concave, their distal ends have two small convexities with a groove between them.

The *second* phalanges have small bodies; their bases have two concavities with a ridge between; the anterior ends, two convexities with an intermediate groove.

The *third* phalanges are still smaller. The articulating base has two concavities and a ridge. The extremity is rough and flattened.

THE TEETH.

Man has two sets of teeth: first, twenty small *deciduous* or *milk* teeth; afterwards thirty-two permanent teeth. Of the former, there are in each jaw four *incisors*, two *canines*, and four back

Fig. 28.

EIGHT TEETH OF ONE SIDE OF THE UPPER JAW.—1. Incisors. 2. Cuspids or canine teeth. 3. Bicuspids. 4. First two molars. 5. Dens sapientiæ

Fig. 29.

EIGHT TEETH OF ONE SIDE OF LOWER JAW.—1. Incisors. 2. Cuspids or canine teeth. 3. Bicuspids. 4. First two molars. 5. Dens sapientiæ.

teeth or *molars*. Of the permanent set, in each jaw, *four* in front are incisors, *two* (one on each side) are canines, *four* (two on each side) are bicuspid or premolars, and *six* (three on each side) molars.

Each tooth has a projecting *crown*, a *neck*, and a concealed *fang* or root. The root is implanted in the *alveolus* of the jaw; which is lined with periosteum.

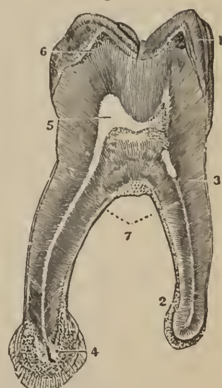
The edge of the *incisor* tooth is cutting, as the name implies; the crown is wedge-shaped; the fang is long and single. The upper incisors are largest.

The *canines* have a conical, somewhat pointed crown, and a single fang, longer than that of the incisors. The upper ones are largest.

The *premolar* or *bicuspid* teeth have the surface of the crown divided, not deeply, into two cusps or prominences. Their fangs are single, but with a partial division, especially at the apex. The upper ones are larger than the lower.

The *molars* have broad crowns, surmounted by four or five tubercles. The *first* and *second* molars have three fangs in the upper jaw, two in the lower; the *third* (wisdom tooth) has one fang, grooved as though becoming divided into three or two.

Fig. 30.



MAGNIFIED SECTION OF A TOOTH.—1. Enamel. 2, 7. Cementum. 3. Ivory. 4. Foramen. 5. Dental cavity. 6. Osseous corpuscles.

Structure of the Teeth.

Each tooth, in vertical section, shows an interior cavity containing the *pulp*, with the bloodvessels and nerves belonging to it. The solid tooth consists of *dentine*, *enamel*, and *cementum* or *crusta petrosa*.

Dentine differs in structure from bone; being shown by the microscope to consist of minute wavy and branching *tubuli*, about $\frac{1}{4500}$ of an inch in diameter, imbedded in the dense *intertubular tissue*. The tubuli are vertical in the summit of the crown, oblique in the neck, and inclined downwards in the lower part of the neck.

Enamel is the hardest part of a tooth. It forms a thin crust over the exposed part of the crown, thinning down towards the neck. Microscopic examination shows it to be composed of parallel six-sided columns, directed vertically at the summit of the crown, and horizontally at the sides.

Cementum or *crusta petrosa* is intermediate in compactness between enamel and dentine. It covers the fangs of the teeth. Its structure is like that of bone, having the Haversian canals and lamellæ.

Chemically, teeth are composed of phosphate and carbonate of calcium, traces of fluoride of calcium, and other salts, and a little

gelatinoid animal matter. Dentine has seventy-two parts of mineral matter and twenty-eight parts of gelatin.

Development of the Teeth.

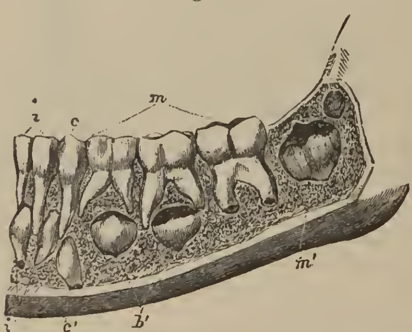
In the sixth and seventh week of fœtal life the germs of the milk-teeth begin to form in a groove of the maxillary mucous membrane. Calcification of the permanent teeth commences a little before birth; both sets of teeth being thus in the jaws together, long before their eruption.

Early in fœtal life, the dental groove becomes closed over and subdivided by septa into *follicles*, within each of which a *papilla* arises. The follicles then change into *dental sacs*, and the papillæ into *tooth-pulps*. Within the enlarging sac, but at the expense of the pulp, the dentine forms. From the lining of the dental sac is developed (at first quite soft) the *enamel organ*, composed of fibres, united to the dentine of the pulp-surface. In the place of their contact, called the *enamel membrane*, the mineral deposition which gives the enamel hardness occurs.

Eruption of the teeth takes place when their size and hardness induce absorption of the gum by pressure.

Of the *milk-teeth*, the *central incisors* come through the gum at about the seventh month of infancy; those of the lower jaw usually first. *Lateral incisors*, eighth to tenth month; *anterior molars*, twelfth to fourteenth month; *canines* (stomach and eye teeth), fourteenth to twentieth month; *posterior molars*, eighteenth to thirty-sixth month.

Fig. 31.



TEETH AT FIVE YEARS.—*i*. Temporary incisors. *c*. Temporary canine. *m*. Temporary first and second molar, and first permanent molar. *i'*. Permanent incisors. *c'*. Permanent canine. *b'*. Permanent bicuspids. *m'*. Permanent second molar.

Permanent teeth come out as follows: Between six and a half and seven years of age, the *first molars;* seventh year, *middle incisors;* eighth year, *lateral incisors;* ninth year, *first premolar;* tenth year, *second premolar;* eleventh to twelfth year, *canine;* twelfth to thirteenth year, *second molars;* seventeenth to twenty-first year, *last molars.*

CHAPTER II.

THE ARTICULATIONS.

Ligaments, *cartilages*, and *synovial membranes* constitute the apparatus of the joints between the bones.

Ligaments are either of *white fibrous* or *yellow elastic* tissue. Of the latter the *ligamentum nuchæ* and *ligamenta subflava* of the spine are the principal examples.

Cartilages are either *temporary* (becoming ossified) or *permanent.* The latter are numerous in the body; being, 1, *articular* cartilages; 2, *costal* cartilages; and 3, various *lamellar* cartilages, as those of the ear, the nose, eyelids, Eustachian tube, larynx, and other parts of the air-passages. The tissue of cartilage is, when minutely examined, found to consist of cells or corpuscles in an intercellular fibro-granular substance. It is, in mass, firm, but elastic and flexible; either pearly white or yellow in color.

Synovial membrane resembles serous membrane in structure, but secretes a peculiar fluid, *synovia;* which is glairy like the white of an egg.

Bursæ are membranous cavities between surfaces which move upon each other; as between the patella and the skin, over the olecranon, outside of the malleoli, between the trochanter major of the femur and the gluteal muscles, etc.

Articulations are of three kinds: *immovable*, *synarthrosis; movable*, *diarthrosis;* and *mixed*, *amphiarthrosis.*

Synarthroses are either *sutura*, with a series of interdentations; *schindylesis*, or dove-tailing, by a thin plate of one being received into a fissure between two laminæ of another; or *gomphosis*, where a conical process is fastened into a socket, as the tooth-fangs are in the alveoli.

Diarthroses are of four kinds: *arthrodia*, which admits of gliding movement, as in the temporo-maxillary articulation; *enarthrosis* or the ball and socket joint, as at the hip; *ginglymus* or hinge, as at the elbow; and *diarthrosis rotatorius*, as between the atlas and axis vertebræ, and between the upper ends of the radius and ulna.

Amphiarthrosis is an articulation with but limited motion; as, for example, that between the ossa pubis—the *symphysis pubis.*

VERTEBRAL ARTICULATIONS.

In front of the bodies of the vertebræ, from the second cervical to the first sacral, lies the *anterior vertebral ligament.* It widens as it descends. Behind, upon the bodies of the vertebræ, from the occiput to the coccyx, is the *posterior vertebral ligament.* Between

each two spinous processes is an *interspinal ligament;* almost wanting, however, in the cervical region. Those in the dorsal region are three-sided; the lumbar ones quadrangular.

The *ligamentum nuchæ* takes the place of the interspinal ligaments in the back of the neck, extending from the occiput to the last cervical spine. It is strong and elastic.

The *ligamenta subflava*, also of elastic fibrous tissue, join the laminæ or bridges of the vertebræ, below the second cervical.

Capsular ligaments surround the oblique or articulating processes; and vertical fibres, somewhat corded in the dorsal region, but scanty elsewhere, join the transverse processes.

The *intervertebral fibro-cartilages*, twenty-three in number, are disks, formed of concentric laminæ at the circumference, and an elastic pulp at the centre; those in the lumbar region are the largest.

Occiput and Atlas.

The articulation here consists of an *anterior* and a *posterior* ligament, and a *capsular* ligament, including together the condyle of the occiput on each side and the oblique process of the atlas.

Atlas and Axis.

Across the ring of the atlas, behind the odontoid or dentate process, stretches the *transverse* or *cruciform* ligament; sending also a fasciculus up to be attached to the occiput, and one down to connect with the odontoid process.

There are also two *anterior atlo-axoid* ligaments, one *posterior atlo-axoid*, and two *capsular* ligaments; the latter connecting the oblique processes.

PELVIC LIGAMENTS.

The sacrum and ilium form together a *symphysis*, on each side, with a cartilage over each articular surface; and, during infancy and pregnancy, a synovial membrane partially developed. Around the symphysis are the short and strong fibres of the *sacro-iliac ligament*, sometimes divided into anterior and posterior. The *sacro-spinal* ligament extends from the transverse processes of the lower sacral vertebræ to the posterior inferior spinous process.

The *ilio-lumbar* ligament connects the crest of the ilium, behind, with the last lumbar transverse process. The *lumbo-sacral* ligament joins the transverse process of the last lumbar vertebra with the upper part of the sacrum on each side. Between the sacrum and the ischium extend the *greater* and *lesser sacro-sciatic* ligaments. The sacro-sciatic notch is by them divided into two foramina for the passage of vessels and nerves, etc.

The *obturator* ligament occupies the obturator or thyroid foramen; it is perforated near its upper margin by vessels.

The triangular *sub-pubic* ligament is immediately under the pubic arch. *Anterior*, *superior*, and *posterior* ligamentous bands surround this arch.

The *symphysis pubis* is an amphiarthrosis, with two oval articular cartilages, with an interspace lined with epithelium; this is more

distinct at the time of pregnancy, when a very slight movement of the bones upon each other may be possible.

TEMPORO-MAXILLARY ARTICULATION.

An *external* and an *internal lateral* ligament and a *capsular* ligament constitute the periphery of this joint. The first is broad, the second forms a sheath for vessels and nerves, the third envelops the condyle of the jaw and the margin of the glenoid cavity of the temporal bone. An inter-articular cartilage and two synovial membranes are contained within the articulation.

The *stylo-maxillary* ligament passes from the styloid process of the temporal bone to the *angle* of the lower jaw.

THORACIC ARTICULATIONS.

Ribs and Vertebræ.—Around the *head* of each rib is a *capsular* ligament. Another capsular ligament joins the *tubercle* of the rib to the *transverse process* of a vertebra.

The *anterior radiated* ligament extends from the head of the rib to the two vertebræ with which it is connected, and to their intervertebral cartilage. The *inter-articular* ligament (except with the first and two last ribs) extends from the head of the rib to the intervertebral cartilage; a distinct synovial membrane is on each side of it. There are, further, the *external*, *internal*, and *middle costo-transverse* ligaments, whose names locate them.

Sternum and Ribs.—The *anterior* and *posterior radiated* or *costo-sternal* ligaments, at the anterior ends of the true ribs, pass from the cartilages of the ribs to the sternum. The anterior is most fully developed. A thin *capsular* ligament completes the connection.

The *costo-xiphoid* ligament joins the cartilage of the sixth and seventh ribs to the sternum.

Sternum and Clavicle.—A *capsular* ligament of considerable thickness surrounds the end of the clavicle and connects it with the sternum. There is an articular cartilage between the bones. Between the sternal ends of the two clavicles passes the *inter-clavicular* ligament. The *rhomboid* ligament extends from the sternal end of the clavicle downwards and inwards to the cartilage of the first rib.

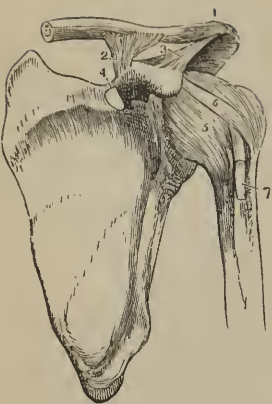
THE SHOULDER.

Clavicle and Scapula.—This articulation has the *superior* and *inferior acromio-clavicular* ligaments, the *coraco-clavicular*, which *divides* into the *conoid* and the *trapezoid*, and, lastly, the small *coracoid* ligament, which bridges the coracoid notch; through the foramen thus made of this notch pass the supra-scapular nerve and artery. There is a fibro-cartilage in the scapulo-clavicular articulation.

Scapula and Humerus.—This is a ball-and-socket joint, with a shallow glenoid cavity; the ligaments being powerfully supported by the surrounding *tendons* and *muscles.*

The ligaments of the shoulder-joint are the *capsular*, the *glenoid*, and the *coraco-humeral* ligaments.

Fig. 32.



LIGAMENTS OF ACROMIO-CLAVICULAR AND SCAPULO-HUMERAL ARTICULATIONS.—1. Superior acromio-clavicular ligament. 2. Coraco-clavicular ligament. 3. Coraco-acromial ligament. 4. Coracoid ligament. 5. Capsular ligament of the shoulder-joint. 6. Ligamentum adscititium, or coraco-humeral ligament. 7. Tendon of long head of the biceps muscle.

The *capsular* ligament is penetrated by the long tendinous head of the biceps. The *coraco-humeral* is sometimes called the *ligamentum adscititium.*

The *glenoid* ligament is a firm marginal band surrounding the upper part of the glenoid cavity, and deepening it.

The *synovial membrane* of this joint communicates with a bursal sac for the tendon of the subscapularis muscle, and sometimes with one for that of the infra-spinatus. The tendon of the biceps has its own synovial sheath, not communicating with that of the joint.

The muscles related to this articulation are, the *supra-spinatus*, long head of the *triceps*, *subscapularis*, *infra-spinatus*, *teres minor*, and long head of the *biceps;* with the *deltoid* more superficially.

Fig. 33.

THE ELBOW.

A *ginglymoid* articulation, chiefly between the humerus and the ulna. The radius supports it by its head, receiving a tuberosity of the humerus into a shallow cup; while the radius also rotates upon the ulna at its upper end.

The ligaments at the elbow are, the *anterior*, *posterior*, and *external* and *internal lateral* ligaments. The synovial membrane of the joint is an extensive one.

Around the neck of the radius, suspending it to the ulna, passes the *orbicular* or *annular* ligament, allowing of rotary motion.

Between the elbow and wrist the radius and ulna are connected, nearly the whole distance, by the *interosseous* ligament. The *round* (*teres*) or *oblique* ligament (sometimes wanting) is a fibrous cord reaching downwards and outwards

INTERNAL VIEW OF THE ELBOW-JOINT.—1 Capsular ligament. 2, 2 Internal lateral ligament. 3. Coronary ligament. 4 Ligamentum teres. 5. Interosseous ligament. 6. Internal condyle.

from the ulna at the base of the coronoid process to the radius below the insertion of the biceps tendon.

THE WRIST.

Lower Radio-ulnar Articulation.—This consists of an *anterior* and a *posterior* ligament, and an articular fibro-cartilage. The synovial membrane of this connection is called *sacciform* from its looseness. Pronation and supination of the forearm and hand depend upon the rotary movement of the radius upon the ulna at their lower junction.

Radio-carpal or *Wrist-joint.*—The end of the radius and the *inter-articular cartilage* join with the *scaphoid*, *lunar*, and *cuneiform* bones of the carpus. The surfaces are all covered by cartilage. The ligaments are the *anterior*, *posterior*, and *external* and *internal lateral.* The synovial membrane is a simple one.

Articulations of the Carpal Bones.—These are, those of the *superior row with each other*, those of the *second row together*, and of the *two rows with each other.* For the first, there are *two palmar*, *two dorsal*, and two interosseous ligaments; for the second, *three palmar*, *three dorsal*, and *two interosseous;* between the two rows, an *anterior* or *palmar*, a *posterior* or *dorsal*, an *external lateral*, and an *internal lateral.* There are *two* distinct *synovial membranes* in the articulations of the carpal bones. The more extended lines the *scaphoid*, *lunar*, and *cuneiform* bones below, and separates them by its prolongations, covers also, and separates, the bones of the lower row; and covers the articular ends of the metacarpal bones. The other synovial membrane lies between the cuneiform and pisiform bones.

Carpo-metacarpal Articulations.—The metacarpal of the *thumb* has a *capsular* ligament connecting it with the *trapezium;* the joint is lined by a distinct synovial membrane.

Fig. 34.

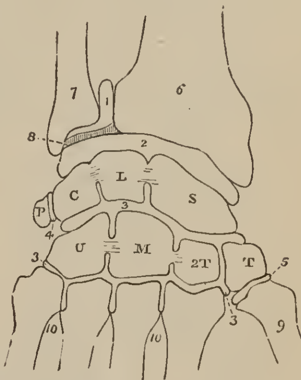


Diagram of the Wrist.—1. Membrana sacciformis (or synovial membrane between the radius and ulna, and the inter-articular fibro-cartilage). 2. Second synovial membrane. 3, 3. Third or large synovial membrane. 4. Synovial membrane between the pisiform and cuneiform bones. 5. Synovial membrane of the metacarpal articulation of the thumb. 6. Lower extremity of the radius. 7. Lower extremity of the ulna. 8. Inarticulate fibro-cartilage. 9. Base of the metacarpal bone of the thumb. 10, 10. Bases of the other metacarpal bones. S. Scaphoid bone. L. Semilunar. C. Cuneiform; interosseous ligaments are seen passing between these three bones. P. Pisiform. T. Trapezium. 2 T. Trapezoid. M. Os magnum. U. Unciform; interosseous ligaments are seen connecting the os magnum with the trapezoid and unciform.

Between the metacarpal bones of the *four fingers* and the carpus pass the *palmar*, *dorsal*, and *interosseous* ligaments. *Similar* ligaments, also, unite the carpal extremities of the metacarpals to each other. A *transverse* ligamentous band unites their digital ends underneath.

ARTICULATIONS OF THE HAND.

The *metacarpo-phalangeal* joints are ginglymoid, the round heads of the metacarpals being received into cavities of the upper ends of the first phalanges. They have an *anterior* and *two lateral* ligaments.

The *inter-phalangeal* articulations are like the above, ginglymoid; and their ligaments are also *one anterior* and *two lateral*.

HIP-JOINT.

The strongest ball-and-socket joint in the body, formed by the head of the femur with the acetabulum. The ligaments are, the *capsular*, *cotyloid*, *teres*, *ilio-femoral*, and *transverse*.

Fig. 35.

Ligaments of the Hip-Joint and Pelvis.—1. Posterior sacro-iliac ligament. 2. Greater sacro-sciatic ligament. 3. Lesser sacro-sciatic ligament. 4. Greater sacro-sciatic notch. 5. Lesser sacro-sciatic notch. 6. Cotyloid ligament around the acetabulum. 7. Ligamentum teres. 8. Line of attachment of the capsular ligament of the hip-joint, posteriorly. 9. Obturator ligament.

The *capsular* ligament extends from the margin of the acetabulum to the neck of the femur, surrounding the whole joint. It is dense and strong, especially above and in front. A synovial bursa separates it from the iliacus and psoas muscles.

The *cotyloid* ligament is an almost cartilaginous ring which deepens the margin of the cavity of the acetabulum. It is thickest above and behind.

The *ligamentum teres* or round ligament is a triangular band, whose base is attached to the bottom of the acetabulum, while its apex is connected with the head of the femur below and behind its centre. It is thus quite within the joint.

The *ilio-femoral* ligament passes obliquely across from the anterior inferior spine of the ilium to the anterior inter-trochanteric line.

The *transverse* ligament crosses the notch at the lower portion of the acetabulum, and converts it into a foramen. It is continuous with the cotyloid.

Fig. 36.

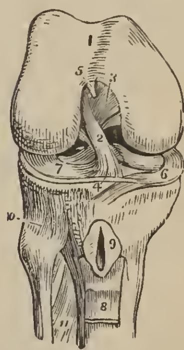
THE Y LIGAMENT, showing its inner and outer fasciculi. The former is known as the ilio-femoral ligament, the ligament of Bertin, etc. This specimen shows the interval between the two fasciculi.

The synovial membrane of this joint is extensive. There is also a mass of fat contained in a fossa of the acetabulum.

KNEE-JOINT.

A hinge between the condyles of the femur and the head of the tibia, with the

Fig 37.



THE KNEE-JOINT LAID OPEN.—1. Lower end of the femur. 2. Anterior crucial ligament. 3. Posterior crucial ligament. 4. Transverse fasciculus. 5. Attachment of ligamentum mucosum. 6. Internal semilunar cartilage. 7. External semilunar cartilage. 8. Ligamentum patellæ. 9. Its bursa laid open. 10. Superior peroneo-tibial articulation. 11. Interosseous ligament.

patella in front. *Outside* of the joint are the *anterior* ligament (ligamentum patellæ); the *posterior* (ligamentum Winslowii); the *internal lateral;* two *external lateral;* and the capsular ligament. *Within* the articulation are the two *crucial* ligaments (anterior external, and posterior internal); two *semilunar cartilages;* the *transverse* and *coronary* ligaments; *ligamentum mucosum*, and *ligamenta alaria.*

The *ligament of the patella* connects the lower point of that bone with the tubercle of the tibia. It is about three inches long. A synovial bursa is between the patella and its ligament and the skin; and a smaller one between the ligament and the tuberosity of the tibia.

The *crucial* ligaments are so called because they cross each other, X-like. They are respectively called anterior and posterior, according to the place of their tibial insertion; each passing from a condyle of the femur across to the other side of the tibia.

The *semilunar fibro-cartilages* are crescent-shaped, and deepen the shallow surfaces (for the condyles) on the head of the tibia. The circumference of each is thicker than its inner concave margin.

The *transverse* ligament connects the anterior parts of the two semilunar cartilages.

The *coronary* ligaments are numerous short fibrous bands joining the margin of the semilunar cartilages with the head of the tibia and surrounding ligaments.

The *synovial membrane* of the knee is the most extensive in the body, projecting above and below the joint beneath tendons and aponeuroses. The *ligamentum mucosum* is a fold of it, of a triangular shape under the patella. The *ligamenta alaria* are fringe-like folds passing on each side from the ligamentum mucosum to the sides of the patella.

TIBIO-FIBULAR ARTICULATIONS.

Superior Junction.—This has an *anterior* and a *posterior* ligament, and a synovial membrane.

Inferior.—Of this the ligaments are, the *anterior*, *posterior*, *transverse*, and *interosseous*. The synovial membrane is connected with that of the ankle-joint.

ANKLE-JOINT.

A perfect hinge, between the tibia and fibula above, and the astragalus below. The tibia rests upon the astragalus; the fibular

Fig. 38.

INTERNAL VIEW OF THE ANKLE-JOINT.—1. Internal malleolus of the tibia. 2, 2. Astragalus. 3. Os calcis. 4. Scaphoid bone. 5. Internal cuneiform bone. 6. Internal lateral or deltoid ligament. 7. Anterior ligament. 8. Tendo Achillis; a small bursa is seen interposed between this tendon and the posterior tuberosity of the os calcis.

Fig. 39.

EXTERNAL VIEW OF THE ANKLE-JOINT.—1. Tibia. 2. External malleolus of the fibula. 3, 3. Astragalus. 4. Os calcis. 5. Cuboid bone. 6. Anterior fasciculus of the external lateral ligament attached to the astragalus. 7. Its middle fasciculus, attached to the os calcis. 8. Its posterior fasciculus attached to the astragalus. 9. Anterior ligament of the ankle.

malleolus supports the side of the articulation. The ligaments are, the *anterior*, the *internal lateral*, and the *external lateral*.

The *anterior* ligament is simple, the *internal lateral* is in two layers, the superficial and the deep. The *external lateral* has three *fasciculi*. The anterior and posterior of these fascicles connect the internal malleolus with the astragalus; the middle one passes from the malleolus to the os calcis.

The synovial membrane of the ankle-joint invests the lining of the ligaments and goes for a short distance between the tibia and fibula.

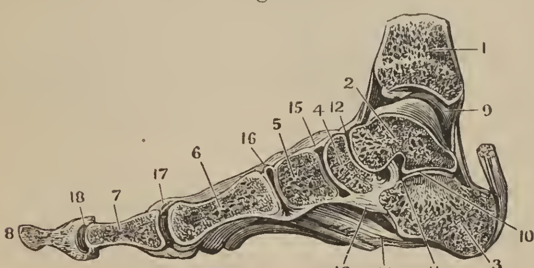
TARSAL ARTICULATIONS.

The *calcaneo-astragaloid* ligaments are, the *external*, the *posterior*, and the *interosseous*. The *last* is the principal connection between the bones. It is composed of many fibres, vertical and oblique. This articulation has two synovial membranes.

Between the *scaphoid*, the *cuboid*, and the *three cuneiform* bones the union is maintained by the *dorsal*, *plantar*, and *interosseous* ligaments.

The *os calcis* is connected with the *cuboid* by two *dorsal* ligaments —the *superior* and the *internal calcaneo-cuboid*, and by two *plantar*,

Fig. 40.



VERTICAL SECTION OF THE ANKLE-JOINT AND FOOT.—1. Tibia. 2. Astragalus. 3. Os calcis. 4. Scaphoides. 5. Cuneiforme internum. 6. Metatarsal bone of the great toe. 7. First phalanx of the great toe. 8. Second phalanx of the great toe. 9. Articular cavity between the tibia and astragalus. 10. Synovial capsule between astragalus and calcis. 11. Calcaneo-astragaloid interosseous ligament. 12 Synovial capsule between astragalus and scaphoides. 13. Calcaneo-scaphoid ligament. 14. Calcaneo-cuboid ligament. 15. Synovial capsule between scaphoides and cuneiforme internum. 16. Synovial capsule between cuneiforme internum and first metatarsal bone. 17. Metatarso-phalangeal articulation of the great toe, with the sesamoid bones below. 18. Phalangeal articulation of the great toe.

the *long* and the *short calcaneo-cuboid* ligaments. The *os calcis* and *scaphoid* are united by two ligaments, the *superior* and the *inferior calcaneo-scaphoid*.

The *astragalus* forms with the *scaphoid* a limited ball-and-socket joint; the posterior concavity of the scaphoid receiving the round

head of the astragalus. Dislocation sometimes occurs in this articulation.

Four synovial membranes exist in the tarsus; one, *posterior calcaneo-astragaloid;* one, *anterior calcaneo-astragaloid* and *astragalo-scaphoid;* a third, *calcaneo-cuboid;* a fourth, between the *scaphoid* and *three cuneiform*, between the *cuneiform*, between the *cuboid* and the *external cuneiform*, and between the *middle* and *external cuneiform* and the *second* and *third metatarsal* bones.

METATARSAL AND PHALANGEAL ARTICULATIONS.

Tarso-metatarsal.—The *three cuneiform* bones and the *cuboid* join with the five metatarsals. The *internal cuneiform* receives that of the *great toe.* The *second* metatarsal goes against the *middle* cuneiform, between the internal and external ones. The *third* metatarsal is connected with the *external cuneiform;* the *fourth* with the same bone and also the *cuboid;* and the *fifth* with the *cuboid.* Inter-articular *cartilages* cover the surfaces, between which there are *three* synovial membranes; the strength of the union being also maintained by *dorsal*, *plantar*, and *interosseous* ligaments.

Inter-metatarsal ligaments are, the *dorsal*, *plantar*, and *interosseous.*

Metatarso-phalangeal.—The round heads of the metatarsal bones are received into concavities of the first phalanges; the connecting ligaments are, the *anterior* or *plantar*, and two *lateral.*

Phalangeal Articulations.—Like those of the hand, the phalanges of each toe are united together by (at each joint) one *anterior plantar*, and two *lateral* ligaments. Synovial membranes line these articulations.

CHAPTER III.

DIGESTIVE ORGANS.

Mouth.

THE *roof* of the mouth is formed by the hard *palate* in front, and the soft palate behind; its *floor* by the *mylo-hyoid muscles.* It opens posteriorly into the *fauces.* The mouth is lined by a mucous membrane, continuous with the lining of the pharynx, larynx, and nares, and, upon the lips, with the skin. Under the tongue is a doubling of this membrane, the *frænum linguæ.* A frænum also exists within each lip at its middle, and one in front of the epiglottis.

The *lips* are chiefly composed of the fibres of the orbicularis muscle, covered externally by fat and skin.

The *gums* are formed of a dense fibrous tissue, connected with the alveolar periosteum around the necks of the teeth; their covering mucous membrane is vascular, but slightly sensitive. Papillæ of capillaries and nerves are numerous upon both the lips and gums.

Tongue.

This, the organ of taste and, in part, of mastication, as well as of articulation, is made up principally of muscular fibres, covered by a mucous membrane supplied with papillæ. The mucous membrane is much the thickest on the dorsum or upper side of the tongue. It consists of a *corium* or basement membrane covered with *epithelium*.

The *papillæ* of the tongue are described as *maximæ* (circumvallate), *mediæ* (fungiform), and *minimæ* (conical and filiform).

Of the *maximæ* there are eight or ten, all at the posterior part of the dorsum of the tongue, arranged in a V-shape, the point behind.

The *mediæ* or fungiform papillæ are numerous, and scattered over the dorsum, chiefly at the sides and tip; they are deep red in color, and rounded.

The *minimæ*, conical and filiform, cover two-thirds of the tongue anteriorly. They are minute, and are arrayed in lines nearly parallel with the rows of the *maximæ;* only more transverse near the apex of the tongue. The *filiform* ones have a very thick epithelium, which gives them a whitish appearance; they are also covered by *secondary* papillæ.

In structure the lingual papillæ, like those of the true skin, consist essentially of capillary loops, invested by nervous terminations, and enveloped by epithelial cells. Over the tongue, as well as the lining membrane of the mouth, are many *mucous glands* and *follicles*. The glands abound especially upon the posterior third of the tongue.

Fig. 41.

UPPER SURFACE OF THE TONGUE.—*a*. One of the circumvallate papillæ. *b*. One of the fungiform papillæ. *d*. Conical papillæ. *e*. Glottis and epiglottis.

The two halves of the tongue are distinctly separated by a fibrous septum. The muscles on each side are, the *hyo-glossus*, *genio-hyo-glossus*, *stylo-glossus*, *palato-glossus*, and in its substance the *superior* (or *superficialis*), and *inferior longitudinal* (or *lingualis*) and the *transverse.*

The *arteries* of the tongue are branches of the *lingual*, *facial*, and *ascending pharyngeal*.

Its *nerves* are three: the lingual branch of the *fifth* pair, the *hypoglossal*, and the lingual branch of the *glosso-pharyngeal*.

Salivary Glands.

These are the *parotid*, *submaxillary*, and *sublingual*.

The *parotid*, the largest, is placed just below and in front of the ear, extending from the zygoma above, to the level of the angle of the jaw below; anteriorly, it stretches a short distance over the masseter muscle; posteriorly, it reaches as far as the external meatus, and, below it, to the mastoid process.

The inner surface of the parotid has two processes, one in front of the styloid process of the temporal bone, and one behind it. The external carotid artery passes through the substance of the parotid gland; and, outside of this, also, the common trunk of the temporal and internal maxillary veins. The *socia parotidis* is a small lobe of the gland, occasionally detached from it.

Fig. 42.

Salivary Glands.—1. Parotid gland. 2. Duct of Steno. 3. Submaxillary gland. 4. Its duct. 5. Sublingual gland.

The *duct* of the parotid (duct of *Steno*) opens inside of the cheek opposite to the second molar tooth of the upper jaw. It is about two inches and a half in length.

The *submaxillary* gland is of considerably smaller size. It lies in a fossa of the inner face of the lower jaw-bone, near its angle. The platysma myoides muscle covers it. Its duct (of *Wharton*) opens under the tongue, near its frenum.

The *sublingual* is the smallest of the three glands. It is almond shaped, and lies under the tongue, on each side, imbedded between the mucous membrane and the mylo-hyoid muscle. It has from

eight to twenty ducts (ducts of *Rivinus*), which open at the side of the frenum; some of them connect with the duct of the submaxillary.

The salivary glands are all conglomerate in structure, made of lobes subdivided into lobules; each of the latter consisting of many closed cells, connected with a common duct.

Palate.

The *hard* palate reaches from the alveoli in front of the upper jaw to the line of junction of the soft palate behind. A ridge or *raphe* runs along its middle line, continuous with a similar line upon the soft palate. The small palatal mucous glands are numerous between the mucous membrane and the bone.

The *soft* palate (velum pendulum) is a thick flexible fold of mucous membrane, embracing muscular fibres, bloodvessels, etc. It is convex behind, where it is continuous with the floor of the posterior nares. At the sides it passes into the walls of the pharynx; below, its border is free.

The *uvula* is a conical projection, of similar structure, downward from the soft palate. On each side, from its base, pass the *anterior* and *posterior half arches* of the palate; the anterior to the base of the tongue, the posterior to the pharynx. The space from side to side between the opposite arches is the *isthmus* of the *fauces*. Between the two half arches, anterior and posterior, on each side, lies the *tonsil*. This is a round gland of variable size, often morbidly enlarged. It is about opposite to the angle of the jaw. The internal carotid and ascending pharyngeal arteries pass outside of it. The tonsil has twelve or more small orifices of minute ducts or follicles.

The muscles of the palate are as follows: *levator palati;* which originates from the petrous portion of the temporal bone, and the Eustachian tube, and is inserted into the soft palate.

Tensor or *circumflexus palati;* arising from the spinous process of the sphenoid and the Eustachian tube. Its tendon passes around the hook of the internal pterygoid process of the sphenoid, to be inserted into the posterior edge of the palate.

Constrictor isthmi faucium; originating at the middle of the soft palate, and passing along the anterior half arch to be inserted into the side of the base of the tongue.

Palato-pharyngeus; origin, soft palate; course, through the posterior half arch; insertion, the wall of the pharynx. Its action is to approximate the palate to the pharynx.

Azygos uvulæ; arising from the posterior nasal spine, it passes through the middle of the soft palate to near the end of the uvula. Its action is to draw up and shorten the latter.

Pharynx.

This, opening downward from the fauces, behind the glottis, is a mucous canal surrounded by connective or cellular tissue and muscles. Below, it is continuous with the œsophagus. Above, the posterior nares and Eustachian tube are in communication with it. It lies against the spinal column, from the occiput to

about the fifth vertebra. Its length is five inches in the adult; its width is greater above than below.

The *epithelium* of the mucous membrane of the pharynx is columnar and ciliated above, and squamous below.

The *superior constrictor* muscle of the pharynx is thin and pale. It arises from the internal pterygoid process of the sphenoid and contiguous parts of the palate bone, upper jaw bone, and side of the tongue. Its insertion is described as being into the middle line of the pharynx; some fibres, partly aponeurotic, passing up and back as far as the basilar process of the occiput.

The *middle constrictor* arises from the greater and lesser cornua of the hyoid bone and the stylo-hyoid ligament. It is inserted into the median raphe of the pharynx. This muscle overlaps the superior constrictor and the stylo-pharyngeus and palato-pharyngeus muscles.

The *inferior constrictor* muscle is the thickest of the three. It arises from the cricoid and thyroid cartilages. Part of its fibres are horizontal, the rest ascend obliquely and overlap the middle constrictor.

The *stylo-pharyngeus* muscle is long and slender; round above, broad and thin below; arising from the styloid process of the temporal bone, to be inserted into the side of the pharynx. Its action is to draw the pharynx upwards and dilate its upper part.

Œsophagus.

This canal begins where the pharynx is narrowest, opposite the fifth cervical vertebra; its length is about nine inches; its width gradually increases below. It passes through a foramen in the diaphragm, and opens by the cardiac orifice into the stomach.

Outside of its mucous and cellular coats, the œsophagus has two layers of muscular fibres; the internal circular and the external longitudinal. The circular fibres are continuous with the inferior constrictor of the pharynx.

The mucous membrane of the œsophagus is reddish above and pale at the lower part. Its epithelium is of the variety called *squamous*. Small compound glands are numerous in the submucous tissue of this canal; each has a single excretory duct.

Abdomen.

This important cavity is, for convenience, divided in description into nine regions. The three upper ones are the *right* and *left hypochondriac*, and, between these, the *epigastric*. The middle regions, the *right* and *left lumbar*, and the *umbilical*. The three lower ones, the *right* and *left iliac*, and the *hypogastric*.

In the *right hypochondriac* region are the *right lobe of the liver*, the *gall-bladder*, *duodenum*, part of the arch of the *colon*, top of the *right kidney*, and *right supra-renal capsule*.

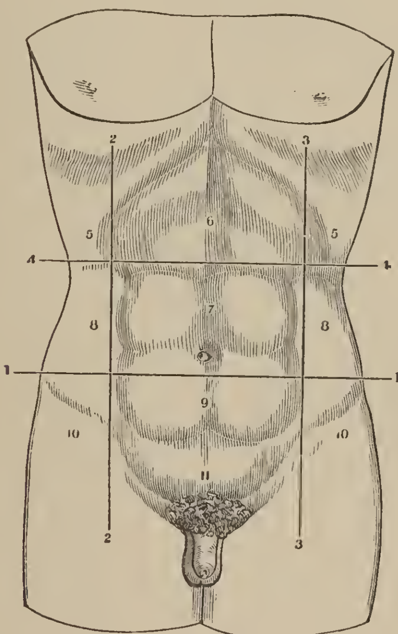
In the *epigastric* region are the left half of the *stomach*, including the *pylorus*, the left lobe of the *liver*, and the *lobulus Spigelii*, the *hepatic artery and vein* and *portal vein*, the *pancreas*, the *semilunar ganglion*, and part of the *aorta*, as well as of the *ascending vena cava*, *vena azygos*, and *thoracic duct*.

The *left hypogastric region* contains the large end of the *stomach*, the *spleen*, the left end of the *pancreas*, part of the *colon*, upper part of the left *kidney*, and left *supra-renal capsule*.

The *right lumbar* region has the *ascending colon*, part of right *kidney*, and part of the *ileum* and *jejunum* (small intestine).

The *umbilical* region contains the transverse part of the *colon*, part of the *omentum majus* and *mesentery*, part of the *duodenum*, and other portions of the *small intestine*.

Fig. 43.



PARIETES OF THE ABDOMEN.—1, 1. Line from the highest point of one ilium to the same point of the opposite one. 2, 2. Line from the anterior superior spinous process to the cartilages of the ribs. 3, 3. A similar one for the opposite side. 4, 4. Line drawn perpendicularly to these. 5, 5. Right and left hypochondriac regions. 6. Epigastric region. 7. Umbilical region. 8, 8. Right and left lumbar regions. 9. Hypogastric region. 10, 10. Right and left iliac regions. 11. Lower part of the hypogastric, sometimes called pubic.

In the *left lumbar* region are the *descending colon*, lower part of left *kidney*, and part of the *small intestine*.

In the *right iliac* region lie the *cæcum* or *caput coli*, with the *vermiform appendix*, the *ureter*, and the *spermatic vessels*.

In the *hypogastric* region are portions of the small intestine, the

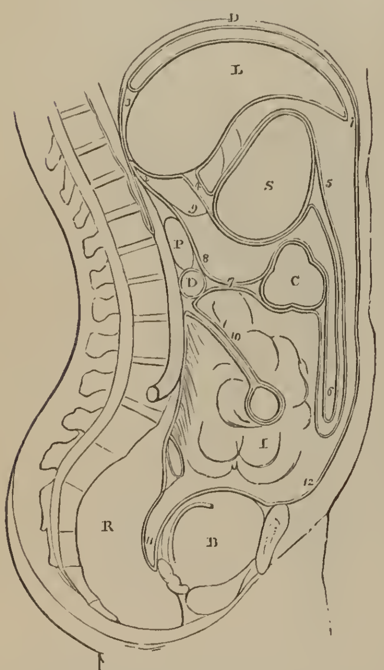
bladder in the child, or in the adult when it is distended, and the *uterus* in the *pregnant* female.

The *left iliac* region holds the sigmoid flexure of the *colon*, the left *ureter*, and *spermatic vessels*.

Peritoneum.

This is the most extensive serous sac in the body; thin, transparent, and moistened with serum like other serous membranes. It is duplicated over all the viscera of the abdomen and the inner wall of the cavity itself; while certain folds of it act the part of ligaments to fix or suspend the viscera. *Omentum* is the name applied to the intermediate double folds of the peritoneum.

Fig. 44.



THE PERITONEUM.—D. Diaphragm. L. Liver. S. Stomach. C. Transverse colon. D. Transverse duodenum. P. Pancreas. I. Small intestines. R. Rectum. B. Bladder.

The *omentum minus* connects the *stomach and the liver; omentum majus* passes from the *stomach to the colon;* the *meso-colon* fixes the colon to the vertebral column; the *mesentery* connects the folds of the small intestine with the abdominal walls. The gastro-colic or greater omentum hangs over the intestines, apron-like; it is sometimes named the *caul*.

The reflections of the peritoneum may be successively traced as follows, beginning at the umbilicus: upward, within the wall of the abdomen, to the diaphragm; backwards under that; forwards over the liver, and back under it most of its width; then forward over the stomach, and down, apron-like (part of *omentum majus*) in front of the colon, to ascend again to its under surface, pass under it and back to the spine; thence obliquely forward and downward around the small intestine, and returning to the spinal column (*mesentery*), to descend in front of the rectum to near the lower posterior part of the bladder; forward and upward over the upper surface of the bladder, and thence upward within the wall of the abdomen to the starting point at the umbilicus.

The *foramen of Winslow* is a communication between the *cavity of the greater omentum* and the general peritoneal cavity, where the gastric and hepatic arteries pass forward, from the arterial trunk called the cœliac axis, to the stomach and liver. This foramen is bounded above by the lobulus Spigelii, in front by the lesser omentum, behind by the ascending vena cava, and below by the hepatic artery.

In the female, the peritoneal reflections deviate from the lower part in front of the rectum, going thence upwards over a small part of the vagina over the body of the uterus, from the sides of which it extends in the form of the *broad ligaments* to the pelvic walls, and then descending in front of the uterus to the bladder; thence upwards and forwards as in the male, it covers the upper part of the bladder and ascends within the abdominal wall.

The lower part of the rectum, the neck, base, and front of the bladder, and the lower part of the vagina, have no covering of peritoneum. It is deficient also at the ends of the Fallopian tubes in the female.

The *appendices epiploicæ* are pouches of the peritoneum holding masses of fat, along the colon and rectum, especially connected with the transverse colon.

Stomach.

The stomach is placed next within the front wall of the abdomen, below the diaphragm and liver; chiefly in the left hypochondriac and epigastric regions. It is irregularly rounded, the left end much the largest. When full, it is about twelve inches in transverse diameter, and four vertically, in the adult.

The left end of the stomach is sometimes called the *splenic* end, being connected by omentum with the spleen. The right end is the *pyloric* portion; it touches the lower surface of the liver.

The œsophagus empties into the *cardiac orifice*, which is nearest the large end, in the upper portion of the stomach.

The *pylorus* is the valvular opening from the stomach into the duodenum.

Between the cardiac and pyloric orifices, on the upper surface, is the *lesser curvature* of the stomach. The *greater curvature* is between the same points around the lower surface.

Four *coats* of the stomach are described: the *serous*, *muscular*, *cellular*, and *mucous* coats.

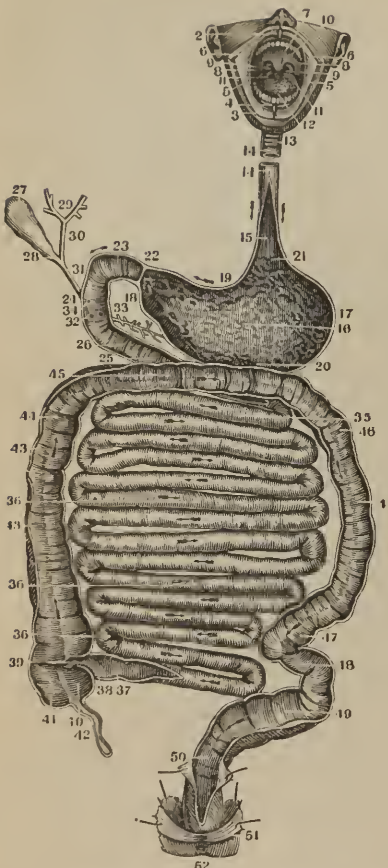
The *serous* coat is an extension of the peritoneum over almost the whole organ.

The *muscular* coat consists of three layers of fibres: *longitudinal*, *circular*, and *oblique*. The first are most superficial; the second are next within them over the whole stomach, but most developed at the pylorus, where they make a ring-like valve. The oblique fibres are most abundant about the cardiac orifice.

The *cellular* coat is formed of loose connective tissue, containing the bloodvessels.

The *mucous* coat is thick, soft, and velvety; pink in color in the young, pale yellow or gray in the adult. Under the microscope it exhibits a honeycomb structure, being covered with depressions from $\frac{1}{100}$th to $\frac{1}{350}$th of an inch in diameter. The *gastric follicles*

Fig. 45.



are minute tubes at the bottom of these depressions; at the pyloric end the follicles are convoluted; elsewhere simple. They secrete mucus in the pyloric region; in other parts, those called the *peptic glands* secrete the *gastric juice*. *Simple* follicles also exist numerously over the mucous membrane of the stomach. Its epithelium is *columnar*.

The *arteries* of the stomach are, the *gastric*, branches of the *hepatic* (right gastro-epiploic and pyloric), and branches of the *splenic* (left gastro-epiploic and vasa brevia). Its *veins* terminate in the *splenic* and *portal* veins.

The *nerves* of the stomach are branches of the right and left pneumogastric, and of the ganglionic or sympathetic.

Intestines.

The small and large intestine together have a length of between thirty and thirty-five feet in all; of which about twenty feet belong to the upper or small intestine.

The *small intestine* is divided in description into

ORGANS OF DIGESTION.—1. Upper lip. 2. Frænum. 3. Lower lip. 4. Frænum. 5. Cheek. 6. Duct of Steno. 7. Roof of mouth. 8. Half arches. 9. Tonsils. 10. Velum pendulum. 11. Tongue. 12. Papillæ. 13. Trachea. 14. Œsophagus. 15. Its interior. 16. Stomach. 17. Its greater end. 18. Its lesser end. 19. Lesser curvature. 20. Greater curvature. 21. Cardiac orifice. 22. Pylorus. 23, 24, 25 Duodenum. 26. Valvulæ conniventes. 27. Gall-bladder. 28. Cystic duct. 29, 30. Hepatic duct. 31. Ductus communis choledochus. 32. Its opening. 33, 35. Jejunum. 34. Opening of pancreatic duct. 36, 38. Ileum. 37. V. conniventes. 39. Ileo-cæcal valve. 40, 41. Cæcum. 42. Appendix vermiformis. 43–48. Colon. 49, 50. Rectum. 51. Levator ani muscle. 52. Anus.

the *duodenum*, *jejunum*, and *ileum*. All of these have a *serous*, *muscular*, *cellular*, and *mucous* coat. The serous coat is a mesenteric extension. The muscular coat has longitudinal and circular fibres. The cellular coat is merely connective. The mucous coat has some peculiarities in the different parts.

Duodenum.

This is named from its length, which is the breadth of twelve fingers or nine or ten inches. It is curved in position, horseshoe like, first ascending, then descending, and then its longest portion going transversely to end in the jejunum. It is in contact, at different parts, with the liver, gall-bladder, pancreas, colon, diaphragm, aorta, and vena cava. The interior of the duodenum is usually stained with bile.

Jejunum.

This makes two-fifths of the small intestine below the duodenum. It has a somewhat greater diameter than the ileum, with thicker walls and more vascularity and color. There is no boundary whatever between the two—the names being somewhat arbitrary.

Ileum.

Three-fifths of the small intestine, almost, have this name. The ileum ends in the *ileo-cæcal valve*, which is between it and the cæcum, in the right iliac fossa.

Mucous Membrane of Small Intestine.

This is covered by *columnar* epithelium. To the unaided eye it presents numerous transverse foldings, called *valvulæ conniventes*. The depth of these is sometimes two-thirds of an inch, usually less. They first appear an inch or two from the pylorus. Large in the duodenum and upper part of the jejunum, they afterwards diminish, and are almost entirely absent in the lower part of the ileum. Their use is to retard the passage of food during digestion and absorption.

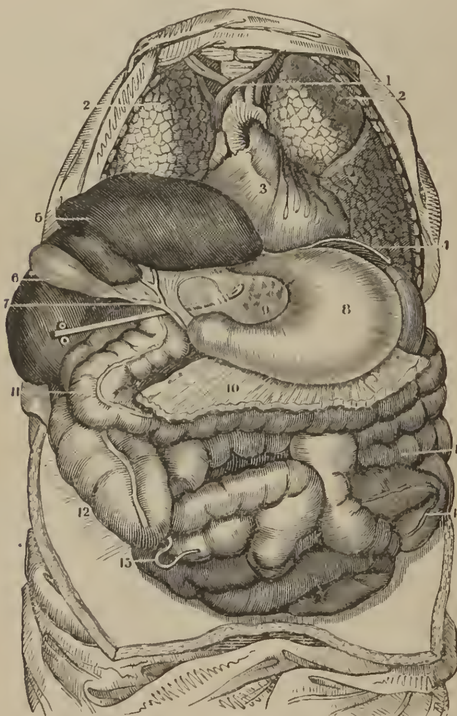
Villi are minute projections from the intestinal mucous membrane, either conical, pyramidal, or cylindrical in shape. From forty to ninety of them have been counted upon the square of a line ($\frac{1}{12}$ of an inch). Each villus contains a minute network of capillaries and lacteal tubes inclosed in basement membrane, on which is a single layer of columnar epithelial cells, perpendicular to the surface. The length of the villi varies from $\frac{1}{39}$ to $\frac{1}{48}$ of an inch.

The *follicles* or *crypts* of *Lieberkühn* are scattered over the lining of the whole of the small intestine. Each is a tubular depression of the mucous membrane, $\frac{1}{600}$ of an inch in diameter, having a circular outlet.

The *glands* of *Brunner* are found only in the duodenum and upper part of the jejunum. They are small, flat, and granular in appearance, with minute ducts—most abundant near the pylorus.

The *solitary glands* are met with in all parts of the small intestines, especially in the lower part of the ileum. They are round and whitish, about $\frac{1}{24}$ of an inch in diameter. Each is a closed sac, with no duct, although around each is a circle of orifices like those of the Lieberkühnian follicles.

Fig. 46.



VISCERA, AFTER REMOVAL OF THE FAT IN THE CHEST AND THE OMENTUM MAJUS OF THE ABDOMEN. THE LIVER ALSO TURNED BACK.—1. Great blood-vessels of the heart. 2. Lungs of each side. 3. Heart. 4. Diaphragm. 5. Liver. 6. Gall-Bladder. 7. Ductus choledochus. 8. Stomach. 9. The gastro-hepatic, or lesser omentum. 10. Gastro-colic, or greater omentum, cut off. 11. Transverse colon. 12. Its ascending portion. 13. Small intestines. 14. Sigmoid flexure. 15. Appendix vermiformis.

Peyer's glands (glandulæ agminatæ) are round or oval *patches* of glands like the solitary glands. The patches vary in length from half an inch to four inches.

Large Intestine.

This comprises the *cæcum*, *colon*, and *rectum*. Its whole length is about five feet. Its diameter is considerably greater than that of the small intestine, and it is more fixed in position. Its division, in description, into three parts is arbitrary, but convenient.

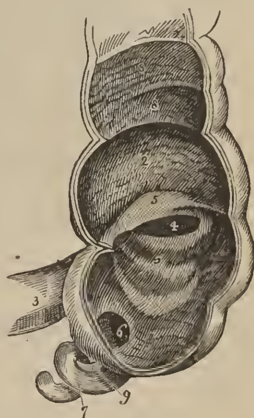
Cæcum.

The cæcum or *caput coli* begins at the ileo-cæcal valve in the right iliac fossa. It has a diameter of about $2\frac{1}{2}$ inches.

The *vermiform appendix* is attached to this part of the bowel. It is about as thick as a goose-quill, and from three to six inches long; it opens into the cæcum by an incomplete valve.

The *ileo-cæcal valve* (valve of Bauhin) is formed of two folds of mucous membrane of semilunar shape, so disposed that distension of the cæcum forces the margins of the folds together, and closes the valve.

Fig. 47.



Ileo-cæcal Valve.—1. Cæcum. 2. Commencement of colon. 3. Ileum. 4. Aperture of entrance of the ileum into the large intestine. 5, 5. Ileo-cæcal valve. 6. Aperture of appendix vermiformis cæci. 7. Appendix vermiformis. 8, 8. Sacculi of the colon. 9. Mesentery of appendix vermiformis.

Colon.

The *colon* has an *ascending*, a *transverse*, and a *descending* portion (*arch* of the colon), and a *sigmoid flexure*. The diameter of the colon is less than that of the cæcum.

The *sigmoid flexure* (named from the letter S) ends in the *rectum*, opposite to the left sacro-iliac symphysis.

Rectum.

The terminal and nearly, though not quite, straight part of the intestine is thus named. It is six or eight inches in length. Its size increases as it descends to the *anus*, its outlet, which is provided with a sphincter muscle.

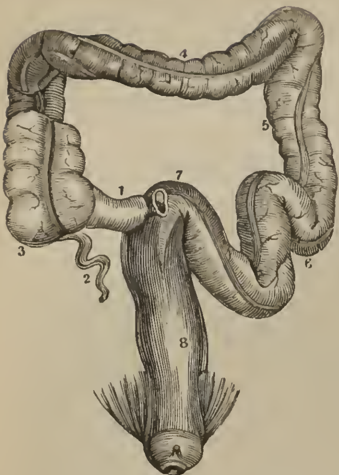
Mucous Membrane of Large Intestine.

This coat is smooth, not villous, but laid in crescentic folds. It is gray or pale yellow in color, darker in the rectum; where also it is thicker and more vascular. Its epithelium is columnar.

Near the lower part of the rectum there are from two to four semilunar *pouches*, half an inch in width.

Simple *follicles*, or tubular depressions, are more numerous in the large than in the small intestine. They have minute round openings.

Fig. 48.



THE LARGE INTESTINE.—1. End of the ileum. 2. Appendix vermiformis. 3. Cæcum, or caput coli. 4. Transverse colon. 5. Descending colon. 6 Sigmoid flexure. 7. Commencement of rectum. 8, 8. The rectum. 9. Anus.

Solitary glands also are abundant, especially in the cæcum and appendix. They are small, flask-shaped, whitish, and each with a very small central outlet.

Liver.

This is the *largest gland* in the body. It chiefly occupies the right hypochondriac region, immediately under the diaphragm, reaching over, however, through the epigastric into the left hypochondriac. Its transverse diameter is from ten to twelve inches; antero-posterior, six to seven inches. Its greatest vertical thickness, three inches; weight, from three to upwards of four pounds.

The liver is convex on its upper surface, and concave below; posterior border round and wide, anterior border thin and sharp, with a deep notch. This border nearly corresponds with the margin of the ribs. The right half of the liver is much the thickest.

It is divided by a fissure and by the *broad* or *suspensory ligament* (peritoneal) into the *right* and *left lobes.* The *right* lobe is much the largest; it is quadrilateral in shape. On the under surface of this lobe are three fissures: the *transverse* fissure, that for the *gall-bladder*, and for the *vena cava.* The colon, right kidney, and supra-renal capsule are in contact with it.

The *left* lobe is convex above, concave over the stomach below. Behind, it reaches nearly to the cardiac orifice of the stomach.

Beneath the right lobe is a portion of the liver called the *lobulus quadratus*, or square lobe.

The *lobulus Spigelii* projects from the back part of the under surface of the right lobe.

The *lobulus caudatus* extends obliquely outwards from the base of the lobulus Spigelii to the under part of the right lobe.

The liver then has, as just described, *five lobes;* it also has *five ligaments* and *five fissures.* The *ligaments* are, all but one, folds of peritoneum. They are called, respectively, the *longitudinal* (broad, suspensory), *two lateral*, *coronal*, and *round* ligaments.

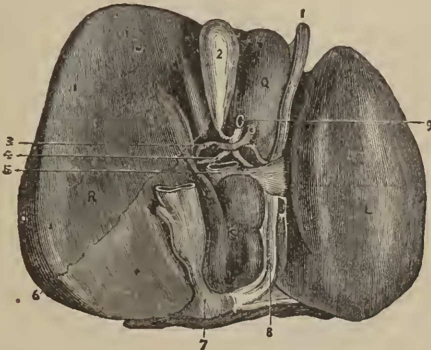
The *longitudinal* or *broad* ligament is principally attached above to the diaphragm; in front, to the sheath of the rectus abdominis muscle.

The *lateral* ligaments are triangular, and are attached to the

diaphragm. The *coronary* ligament connects the posterior border of the liver with the diaphragm.

The *round* ligament (*teres*) is a fibrous cord, the remainder of what was the *umbilical vein*. It may be traced from the navel to the anterior notch of the liver, and along the longitudinal fissure underneath it, as far as to the vena cava.

Fig. 49.



UNDER SURFACE OF THE LIVER.—R. Right lobe. L. Left lobe. Q. Lobus quadratus. S. Lobus Spigelii. C. Lobus caudatus. 1. Umbilical vein in longitudinal fissure. 2. Gall-bladder in its fissure. 3. Hepatic artery in transverse fissure. 4. Hepatic duct in transverse fissure. 5. Portal vein in transverse fissure. 6. Line of reflexion of peritoneum. 7. Vena cava. 8. Obliterated ductus venosus. 9. Ductus communis choledochus.

The *fissures* of the liver are, the *longitudinal*, that of the *ductus venosus* (of the fœtus), the *transverse*, that of the *gall-bladder*, and that for the *vena cava*.

The *vessels* of the liver are, the *hepatic artery*, *portal vein*, *hepatic vein*, *hepatic duct*, and the lymphatics.

The *capsule of Glisson* is a coat of loose connective tissue which envelops the vessels of the liver and accompanies them for some distance through the organ.

The liver is supplied with *nerves* from the *hepatic plexus* of the ganglionic or *sympathetic*, from the *pneumogastrics*, and from the *right phrenic*.

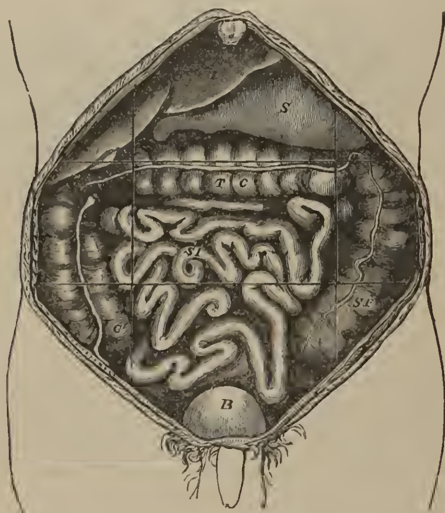
Structure of the Liver.—Its substance (seen to be granular, when torn, by the naked eye) is made up of a great number of minute lobules, each called an *acinus*. The whole liver is penetrated by the vessels already named, and is covered by a *fibrous* and a *serous* or *peritoneal* coat.

Each acinus is about $\frac{1}{10}$ to $\frac{1}{20}$ of an inch in diameter. Its shape, transversely, is polygonal. It is suspended, as it were, by its capillaries, from a branch of the hepatic vein; it is interpenetrated by a plexus of capillaries from the portal vein and hepatic artery,

and surrounded by a plexus of biliary tubuli or ducts; the mass of each acinus being formed of *cells*.

These cells have a diameter, each of $\frac{1}{1000}$ to $\frac{1}{2000}$ of an inch. They are *nucleated*, sometimes with two nuclei. They contain yellow biliary matter, which they secrete from the blood.

Fig. 50.



THE ABDOMINAL VISCERA *in situ*, the great omentum having been removed in order to show the parts more distinctly. The lines mark the regions of the abdomen. L. Liver [left lobe]. S. Stomach. S. I. Small intestine. C. Cæcum. T. C. Transverse colon. S. F. Sigmoid flexure. B. Bladder [distended].

The origin of the bile-ducts is yet undetermined. Kölliker considers them to commence in a network *outside* of the acini. Kiernan and Leidy believe them to ramify *through* and *within* each acinus, its cells being held in their meshes, as well as in those of the capillaries.

All of the biliary ducts conjoin to form two, one for the right and one for the left lobe, which issue at the transverse fissure, and, uniting, make the hepatic duct. This, after an inch and a half, about, of length, joins at an acute angle the *cystic* duct (of the gall-bladder), thus constituting the *ductus communis choledochus*, or common biliary duct, which empties into the duodenum. This *ductus communis* is three inches long, and about as large as a goose-quill. It passes close to, and sometimes through the pancreas.

Gall-Bladder.

This reservoir for bile lies under the liver. It is pear-shaped; having an anterior rounded *fundus*, and a posterior narrow *neck*

or stem. It is about four inches long by one inch broad; and holds eight to ten fluidrachms. It has three coats: serous, fibro-muscular, and mucous. The serous or peritoneal coat covers only its under surface.

Spleen.

A ductless gland, in the left hypochondriac region (opposite the ninth, tenth, and eleventh ribs); oblong, flattened, and rounded, about five inches long, three or four inches wide, and an inch and a half in thickness; in color, dark, bluish-red. It is covered by the peritoneum, and connected with the stomach by omentum. A *suspensory ligament* joins it above to the diaphragm. A vertical fissure, called the *hilus*, divides its inner surface.

Within the *serous* or peritoneal coat is the *elastic fibrous coat* of the spleen. This coat, besides embracing the whole organ, is, at the *hilus*, extended inwards over the vessels. From the sheaths so formed, and from the rest of the coat, many bands (*trabeculæ*) pass in every direction; by their interunion the peculiar areolar structure of the spleen is constituted.

By the presence of this tissue a great degree of *elasticity* is conferred upon the spleen, admitting of great variations of size. It is sometimes remarkably enlarged in ague.

In the interspaces of the trabeculæ is the *proper substance* of the spleen, which is soft and pulpy, and of a dark reddish-brown color.

The *Malpighian corpuscles* are spherical, gelatinous, whitish, semi-transparent bodies, $\frac{1}{25}$ to $\frac{1}{60}$ of an inch in diameter, scattered through the substance of the spleen. They are most distinct in the young subject. They are attached to the sheaths of the smaller arteries, "like moss-rose-buds." Each consists of a capsule formed from the substance of the vessel-sheaths, and containing a soft white pulpy substance, consisting of granules, cells, and nuclei. On the surface of each Malpighian body are ramifications of the arteries, of veins, and a capillary network.

The *splenic artery*, and the *splenic veins*, are very large for the size of the organ. The splenic artery is also tortuous.

The spleen has lymphatic vessels, some of which are deep-seated, and others superficial.

Pancreas.

An oblong, flattened, hammer-shaped conglomerate gland, the *head* being at its right end, embraced by the duodenum; the left end or *tail* reaching to the spleen and left kidney. Its length is six or eight inches; breadth an inch and a half; thickness half an inch to an inch.

The posterior surface of the pancreas is separated from the first lumbar vertebra by the superior mesenteric vessels, vena cava, vena portæ, aorta, left kidney, supra-renal capsule, and vessels.

The *duct* of the pancreas (*ductus Wirsungii*) passes from left to right to open into the duodenum near its middle, by an orifice generally common to it and the ductus communis choledochus. The pancreatic duct is of the size of a goose-quill; it is occasionally double.

In *structure*, the pancreas closely resembles the salivary glands. It is supplied with arteries, veins, lymphatics, and nerves.

CHAPTER IV.

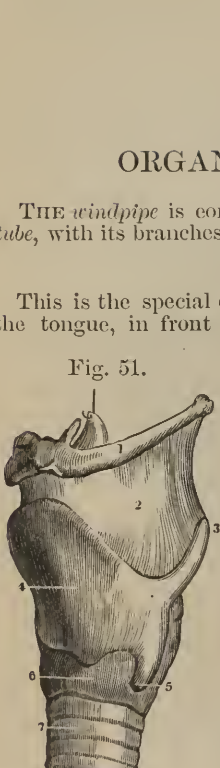
ORGANS OF RESPIRATION.

THE *windpipe* is composed of the *larynx*, *trachea*, and *bronchial tube*, with its branches, communicating with the *lungs*.

Larynx.

This is the special organ of *voice*. It lies just below the root of the tongue, in front of the pharynx and under the skin. It is chiefly composed of cartilages, with a mucous membrane, ligaments, and muscles. In shape, it is triangular above, having a prominent vertical ridge; and cylindrical below.

Fig. 51.



THE LARYNX.—1. Os hyoides. 2. Thyro-hyoid ligament. 3. Cornu majus of thyroid cartilage. 4. Its angle and side. 5. Cornu minus. 6. Lateral portion of cricoid cartilage. 7. Rings of trachea.

Nine cartilages enter into the larynx: the *thyroid*, *cricoid*, *epiglottis*, two *arytenoid*, two *cornicular*, and two *cuneiform*.

The *thyroid* cartilage is the largest. It consists of two flat sides or wings, meeting in front in the ridge called *pomum Adami* or Adam's apple. This ridge is most strongly marked in the male. It is surmounted by a deep notch. Within, the surface of this cartilage is lined with mucous membrane, to which the *chordæ vocales* are attached.

The lower border of the thyroid cartilage is connected to the cricoid, by a membrane in front, and by muscles at the sides.

The posterior border ends above in the *superior cornu*, on each side; which is long and narrow. Below, the same border ends in the *inferior cornu* on each side; which is short and thick.

The *cricoid* cartilage is ring-like in shape, smaller but thicker than the thyroid, and situated below and behind it. It may be described as composed of two halves, anterior and posterior. On each side, at the junction of the two halves, there is a small elevation, to which is attached the lower cornu of the thyroid cartilage.

The under border of the cricoid is connected by membrane with the first ring of the trachea.

Its upper border slopes upwards and backwards between the wings of the thyroid. At the highest point, on each side, it supports on an oval surface the arytenoid cartilage.

The cricoid cartilage is lined by mucous membrane continuous with that of the thyroid.

The *arytenoid* cartilages are small and pyramidal; they rest upon the cricoid at the back of the larynx, one on each side. The apex of each is curved backwards and inwards, and surmounted by the small conical *cornicular* cartilage (cartilage of Santorini).

The *cuneiform* cartilages (of Wrisberg) are just in front of the arytenoid; they are quite small, of elongated shape, lodged in the mucous membrane between the arytenoid cartilages and the side of the *epiglottis*.

The *epiglottis* is the lid of the upper aperture of the larynx called the *glottis*, which is considered to extend to the inferior vocal chords. The *rima glottidis* is the fissure between those chords.

The epiglottis is a thin fibro-cartilage, attached to the upper front border of the thyroid by a narrow neck, and having a broad and round free margin, which is vertical during respiration, but closed backwards over the glottis in swallowing.

The *external ligaments* of the larynx are as follows:—

Connecting the thyroid cartilage with the hyoid bone, three—the *thyro-hyoid membrane* and two *lateral thyro-hyoid ligaments*.

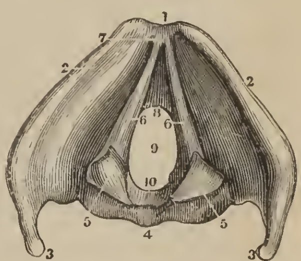
Between the thyroid and cricoid cartilages, three—the *crico-thyroid* membrane and two capsular ligaments, each with a synovial membrane. The latter join the cricoid to the lower cornua of the thyroid.

The cricoid and arytenoid cartilages are connected by strong *posterior crico-arytenoid* ligaments and thin and loose *capsular* ligaments.

The ligaments of the *epiglottis* are the *hyo-epiglottic* and *thyro-epiglottic* ligaments. It is connected also with the base and sides of the tongue by three folds of mucous membrane.

The *superior aperture* of the larynx is almost cordiform, widest in front. The laryngeal cavity extends from the epiglottis to the lower edge of the cricoid cartilage. The vocal chords and their connections divide it into two parts.

Fig. 52.



View of the Larynx from Above.—1. Superior edge of the larynx. 2. Its anterior face. 3. Cornua majores of thyroid cartilage. 4. Posterior face of cricoid cartilage. 5, 5. Arytenoid cartilages. 6, 6. Thyro-arytenoid ligaments. 7. Their origin. 8. Their terminations. 9. Glottis. 10. Cricoid cartilage.

The *chords* are called *inferior* and *superior*, or *true* and *false* vocal chords. The latter are formed of mucous membrane only; in the inferior or true vocal chords are ligamentous fibres also. The orifice of the glottis varies in shape and size during vocalization and respiration.

The *ventricle* of the larnyx (of Galen) is a cavity on each side, between the superior and inferior vocal chords.

The *sacculus* or *pouch* of the larynx (sinus of Morgagni) is a small

conical sac in front of and higher than the ventricle, communicating with it by a narrow opening. It yields a secretion which lubricates the vocal chords.

The *muscles* of the larynx are, the *crico-thyroideus*, *crico-arytænoideus lateralis*, *crico-arytænoideus posticus*, *arytænoideus transversus*, and *thyro-arytænoideus*.

The *crico-thyroid* muscle, on each side, passes upwards and outwards from the front and side of the cricoid cartilage, to the lower and inner border of the thyroid. The *action* of these muscles is, by drawing the thyroid cartilage down, to *elongate* and *make tense* the vocal chords.

The *crico-arytænoideus posticus* passes from the posterior part of the cricoid cartilage, on each side, to the base of the arytenoid. Its action is, by drawing the arytenoid cartilages outwards and backwards, to *open the glottis*, *making the chords tense* at the same time.

The *crico-arytænoideus lateralis*, on each side, arises near the front of the upper border of the cricoid, and passes upwards and backwards to be inserted into the base of the arytenoid. The action of the *lateralis* is, by rotating the arytenoid cartilages, to approximate their anterior faces, and thus narrow the orifice between the vocal chords.

The *arytænoideus transversus* is a single muscle, crossing upon the back of the two arytenoid cartilages, from one to the other. Some of its fibres are oblique. Its action is to draw the two cartilages together, and thus to narrow the glottis.

The *thyro-arytænoideus* is a broad, flat muscle, within the larynx on each side, lying parallel with the inferior vocal chord, passing from the thyroid back to the front surface of the base of the arytenoid. Its action is to draw the arytenoid forward towards the thyroid, thus *relaxing* the vocal chords.

The *thyro-epiglottidei* muscles depress the epiglottis. The *arytæno-epiglottideus superior* constricts the rima glottidis when the epiglottis closes over it for deglutition. The *arytæno-epyglottideus inferior* compresses the *sacculus laryngis*.

Trachea.

Continuous with the larynx, below it, is this tube; four or five inches in length, to the level of the third dorsal vertebra; there it branches into the right and left *bronchi*. The trachea is composed of eighteen or twenty *imperfect rings* of *cartilage*, completed in the posterior third of each by *muscular* fibres, and united by fibrous and elastic ligaments. The muscular fibres are both longitudinal and transverse; the former most external. They are *unstriped* and *involuntary*. The trachea and bronchi are lined by mucous membrane.

The *black bronchial glands* are lymphatic glands, situated at the bronchial bifurcation.

The *right bronchus* is *shorter* and *larger* in calibre than the left. Both ramify into a multitude of branches or *ramules*, terminating finally in the lungs, in direct communication with the air-vesicles. Fine muscular fibres are discovered by the microscope even in the smaller ramules.

Thyroid Gland.

This is a ductless gland, formed of two lobes, one on each side of the trachea, with an *isthmus* connecting them, across the second and third tracheal rings. Its weight is one or two ounces; color, brownish-red. It is largest in females; increasing a little during menstruation. It is much enlarged in *goitre* or *bronchocele.* The right lobe is somewhat larger than the left.

In structure, this gland is composed of minute closed vesicles invested by a dense capillary network, combined into lobules by connective tissue. The vesicles are almost spherical, and contain a yellowish fluid.

Thymus Gland.

This, too, is a ductless gland. It attains its full size at two years of age; it is then gradually absorbed, and almost ceases to exist at the time of puberty. It is situated in the lower part of the neck, in the anterior *mediastinum*, behind the sternum. It consists of two unequal lobes, united together, with sometimes an intermediate lobe. Its color is pinkish-gray. At its full development, it is about two inches long, one and a half wide, and a quarter of an inch in thickness.

In *structure*, the lobes of the thymus are composed of numerous lobules, with a common dense capsule. Each lobule (varying in size from that of a pin's head to that of a pea) contains a number of smaller lobules, around a central cavity. These lesser or secondary lobules are also hollow. The latter communicate with the cavities of the primary lobules, and these open into a great central cavity, the *reservoir* of the thymus, which extends through the length of each lateral lobe of the gland. A white milky fluid is found in this reservoir.

In its *development*, the thymus has been shown to begin as a linear tube, with *diverticula* from it.

Lungs.

Each lung is conical; with the apex above, and a concave base, lower behind than in front. The *right* lung is *largest*, being broader and *shorter* than the left; it has *three* lobes, the left but *two.* The fissure is posterior and deep, between the two lobes of the left lung, and between the upper and lower of the right; a shorter fissure separates the middle triangular lobe from the upper one of the right lung.

The *root* of the lungs is the place of their connection with the windpipe and the heart, by the bronchi and the bloodvessels, nerves, etc. *Most anterior* are the pulmonary veins; next the pulmonary artery; behind, the bronchus, for each lung. From above downwards, on the right side, the succession is, bronchus uppermost, then pulmonary artery, lowest pulmonary veins; on the left side, pulmonary artery, bronchus, pulmonary veins.

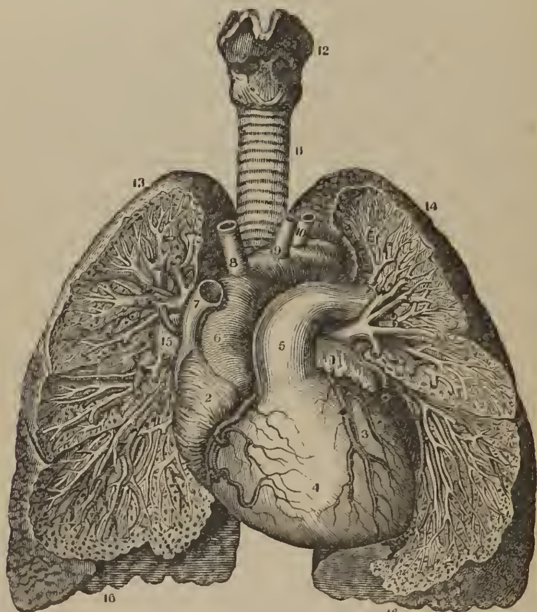
The lungs together weigh about 42 ounces; less in the female. Their color is pinkish-white at birth, mottled with slate-colored patches in the adult, the patches growing black with age. The

lung-substance is light, spongy, and elastic, crepitating under pressure, and floating in water. When removed from the chest the lungs collapse.

Each lung has a *serous coat*, a part of the pleura, an elastic *areolar* or *connective tissue*, and the *parenchyma* or proper substance of the lung.

The *parenchyma* is formed of lobules, most easily separable in the fœtus. They vary in size and form. Each consists of the terminal ramifications of a bronchial branch, with their air-cells, and the attendant bloodvessels, lymphatics, and nerves; all united by fibrous connective tissue.

Fig. 53.



Bronchi and Bloodvessels.—1. Left auricle. 2. Right auricle. 3. Left ventricle. 4. Right ventricle. 5. Pulmonary artery. 6. Arch of the aorta. 7. Superior vena cava. 8. Arteria innominata. 9. Left primitive carotid artery. 10. Left subclavian artery. 11. Trachea. 12. Larynx. 13. Upper lobe of right lung. 14. Upper lobe of left lung. 15. Trunk of right pulmonary artery. 16. Lower lobes of the lungs.

The bronchial ramules are formed of many cartilaginous pieces, with a mucous membrane lined with *ciliated* columnar epithelium. When the size of these ramules becomes reduced almost to $\frac{1}{40}$th of an inch, they become irregular, losing their cylindrical form, and opening in every direction into the air-cells.

The *air-cells* are many-sided, divided from each other by their walls or *septa* of a diameter from $\frac{1}{70}$th to $\frac{1}{200}$th of an inch. They, as well as the last bronchial intercellular passages, are lined by a thin mucous membrane, with a *squamous epithelium.* The number of these air-cells in an adult is estimated to be several hundred millions.

By the *pulmonary artery* and its branches, all the venous blood of the body is carried from the heart to the lungs, where it is distributed minutely amongst the air-cells by finely-divided meshes of capillaries with thin walls. From their network arise the pulmonary veins, which return the blood to the heart.

The *bronchial* arteries furnish blood to the lungs for their nutrition. Some of their branches and capillaries terminate in the bronchial, and others in the pulmonary veins.

The *nerves* of the lungs are supplied chiefly from the pneumogastric and sympathetic or ganglionic. The lungs have also superficial and deep *lymphatics.*

Pleuræ.

These are the serous coverings of the lungs, reflected, from their roots, over the inner walls of the thorax. The portion over the lung is the *pleura pulmonalis*, and that over the ribs, *pleura costalis.* Between the two is the *cavity of the pleura.* Like the other serous membranes, the pleura is thus a *closed sac* or double membrane.

The pleura rises over the apex of each lung, about an inch above the first rib, through the upper orifice of the thorax. Below, it covers the diaphragm.

The *anterior mediastinum* is the interspace between the two pleuræ in front, above and below their point of contact behind the sternum, just above its middle. This cavity is limited behind by the pericardium.

The *middle mediastinum* is a broader inter-pleural cavity, containing the heart, in its pericardial sac, the ascending aorta, descending vena cava, bifurcation of the trachea, pulmonary arteries and veins, and phrenic nerves.

The *posterior mediastinum* is a triangular space, in front of the spinal column, bounded in front by the pericardium and roots of the lungs, and at the sides by the two pleuræ.

CHAPTER V.

URINARY AND GENITAL ORGANS.

Kidneys.

Each kidney is situated in the lumbar region, from the level of the eleventh rib to near the crest of the ilium; the right one being a little the lowest. It is surmounted by the *supra-renal capsule*, and surrounded by fat. Its position is maintained chiefly by its bloodvessels.

The kidney is somewhat convex in front, and flattened posteriorly; convex on its external border, and concave on the internal margin; the upper end thicker and rounder than the lower.

The right kidney is in contact in front with the liver, duodenum, and ascending colon; the left kidney, with the stomach, spleen, pancreas, and descending colon.

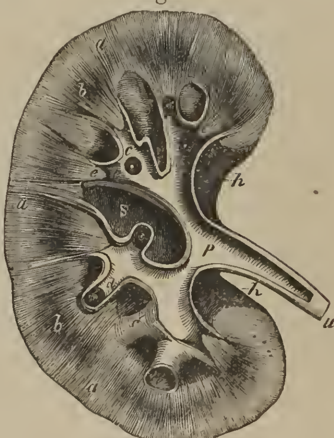
The *hilus* of the kidney is a deep notch in its internal border, where the vessels pass in and out. The *pelvis* of the kidney is the concavity within it.

Each kidney is about four inches long, by two in width and one in thickness in the adult; weight, $4\frac{1}{2}$ to 6 ounces, half an ounce less in the female. The left kidney is longest, thinnest, and lightest by about 2 drachms.

A fibrous capsule surrounds the kidney, and enters at the hilus to invest the bloodvessels and beginnings of the excretory duct.

The general color of the kidney substance is deep red. It is firm on pressure, but easily torn; and is divisible into the *cortical* or external, and the *medullary* substance.

Fig. 54.



PLAN OF A LONGITUDINAL SECTION THROUGH THE PELVIS AND SUBSTANCE OF THE RIGHT KIDNEY, ½.—*a*. The cortical substance. *b*, *b*. Broad part of the pyramids of Malpighi. *c*, *c*. The divisions of the pelvis named calyces laid open. *c'*. One of these unopened. *d*, *d*. Summits of the pyramids or papillæ projecting into calyces. *e*, *e*. Section of the narrow parts of two pyramids near the calyces. *p*. Pelvis or enlarged divisions of the ureter within the kidney. *u*. The ureter. *s*. The sinus. *h*. The hilus.

The cortical substance forms an external layer of about $\frac{1}{6}$th of an inch in thickness, with prolongations inwards. Scattered numerously through it are the small red *Malpighian bodies;* around these are small granular cells, convoluted *tubuli uriniferi* (tubes of *Ferrein*), bloodvessels, lymphatics, and nerves.

The Malpighian bodies have a diameter of about $\frac{1}{120}$th of an inch. Each is a *capillary tuft* inclosed in a membranous capsule, the beginning of one of the uriniferous tubules. The tufts are the networks of small arteries (*vasa afferentia*); and from them and the capillary plexus outside of them go minute veins (*vasa efferentia*), which also form plexuses around the tubuli uriniferi.

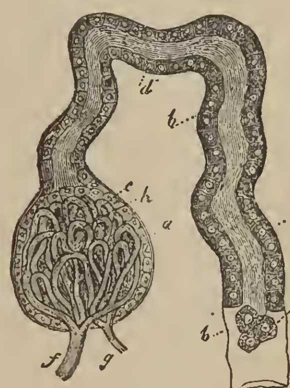
The medullary substance is formed of pale red cones (*pyramids of Malpighi*) about fifteen in number, with their apices (*papillæ* of the kidney) projecting into the central cavity of the gland. Each papilla has about a thousand orifices of tubuli uriniferi. The pyramid of Malpighi is composed of many lesser cones or pyramids (pyramids of *Ferrein*), which are themselves made up of straight tubes (of *Bellini*), the continuations of the convoluted tubuli of the cortical substance.

Over each papilla is an *infundibulum*, or small membranous cup; four or five infundibula together make a *calyx;* and all the calyces, from seven to thirteen in number, open into the *pelvis* of the kidney; from which proceeds the *ureter* or excretory duct.

Fig. 55.

Plan of the Renal Circulation.—*a*. Terminal branch of the artery, giving the terminal twig, 1, to the Malpighian tuft *m*, from which emerges the efferent or portal vessel, 2. Other efferent vessels, 2, are seen entering the plexus of capillaries, surrounding the uriniferous tube, *t*. From the plexus, the emulgent vein, *v*, springs.

Fig. 56.



A Malpighian Body in its Relation to the Uriniferous Tube $\frac{300}{1}$.—*a*. Capsule of the Malpighian body. *d*. Epithelium of the uriniferous tube. *e*. Detached epithelium. *f*. Afferent vessel. *g*. Efferent vessel. *h*. Convoluted vessels of the glomerulus.

The ureter is a tube of the diameter of a goose-quill; it has a fibrous, a muscular, and a mucous coat. It passes obliquely inwards and downwards for the length of sixteen or eighteen inches, behind the peritoneum, to enter the base of the bladder. The entrances of the two ureters are about two inches apart.

The *renal artery*, which supplies the kidney, is a large vessel in

proportion to the size of the gland. As it enters the hilus it divides into four or five branches. The *renal vein* empties into the vena cava. The kidney has superficial and deep lymphatic vessels.

Supra-Renal Capsules.

These are small, flat, yellowish bodies, behind the peritoneum, one in front of the upper end of each kidney, classed with the "ductless glands." They vary in size in different individuals, but the left is usually the largest—average length, an inch and a half; width, an inch and a quarter; thickness, one-fifth of an inch.

In *structure* the capsule has an *external cortical*, and an *internal medullary* substance. The former is most extensive; and is formed of narrow columns perpendicular to the surface. The medullary substance is soft, pulpy, and brown in color.

Microscopical anatomists differ in their views of the minute character of the columnar masses. The medullary substance is composed of nuclei and granules, amidst which is a plexus of very small veins.

Nerves abound in the supra-renal capsules; derived from the ganglionic or sympathetic plexuses, and the pneumogastric; one observer says also the phrenic. These nerves have a number of small ganglia upon the surface of the capsules.

Bladder.

Situated behind the pubes, in front of the rectum in the male, and of the uterus and vagina in the female, the bladder rises higher in the *infant* than in the adult. In the *adult*, when *empty*, its summit reaches to the upper line of the symphysis pubis; when filled it rises, in a round form, into the hypogastric region, to a greater or less distance above the bony rim of the pelvis according to its distension. Its vertical diameter is the greatest in the male; the transverse in the female; and its capacity is greatest in the latter.

When moderately full, the male adult bladder measures about five inches by three; and contains a pint.

The *summit* of the bladder is connected with the umbilicus by the *urachus*, a fibrous and partly muscular cord, having on each side of it the remnants of the hypogastric arteries, as round fibrous cords. The urachus, in the embryo, is a tube, by which the bladder communicates with the membranous extra-abdominal sac called the *allantois*.

The *body* of the bladder is only covered with peritoneum on its *posterior* surface.

The *vas deferens* runs in a curve, from before backwards, along the side of the bladder towards its base.

The base or *fundus* of the bladder is directed downwards and backwards. Its dimensions vary with the fulness of the organ.

The *neck* or *cervix* of the bladder is the narrow part connected with the *urethra*. It is, in the male, surrounded by the prostate gland.

The *ligaments* of the bladder are called *true* and *false;* five of the former and five of the latter. The true are, the *two anterior*, going

to the pubes; *two lateral*, which are broader, and are formed of the fascia betwen the bladder and rectum; and the *urachus*.

The *false* ligaments are, the *two posterior*, *two lateral*, and *one superior*. The *posterior* pass in the male to the sides of the rectum; in the female, to the side of the uterus. The *lateral* are folds of peritoneum from the iliac fossæ. The *superior* ligament is a fold of peritoneum from the summit of the bladder to the umbilicus.

The bladder has a partial *serous*, a *muscular*, a *cellular*, and a *mucous* coat.

The *muscular* coat consists of two layers of *unstriped* muscular fibre; longitudinal without, and circular within. The former are most abundant on the front and back surfaces; the latter, around the neck. There they form the *sphincter vesicæ*, continuous with the muscular fibres surrounding the prostate gland. Some *oblique* fibres also go from the prostate to the ureters.

The *mucous* coat is smooth and pale-red. It is most closely united to the muscular coat at the neck. It has a number of small cluster-like (racemose) glands, about the neck, and a few scattered mucous follicles. Its epithelium is intermediate between the squamous and the columnar form.

The *vesical triangle* (*trigonum*) is just beneath the opening of the urethra from the neck of the bladder; its apex is forwards. It is bounded in front by the prostate gland, and at the sides by the vasa deferentia and vesiculæ seminales.

The *uvula vesicæ* is a small elevation of the mucous membrane, or thickening of the prostate, projecting into the orifice of the urethra.

Urethra.

In the male, when the penis is relaxed, this tube has the shape of the italic *S*. Its length is eight or nine inches. It is described as having three parts—the *prostatic*, *membranous*, and *spongy* portion.

The *prostatic* is the widest, is spindle-shaped, and has a length of an inch and a quarter; passing through the prostate gland near its upper surface.

The *caput gallinaginis* or *veru montanum* is a narrow ridge on the bottom of the prostatic portion, three-quarters of an inch long and an eighth of an inch in elevation, containing muscular and erectile tissue. On each side of this are numerous orifices of the *prostatic ducts*, from the middle lobe of the gland. The *prostatic vesicle* or *sinus pocularis* is a fossa a quarter of an inch long, just in front of the veru montanum; about its margins are the openings of the seminal ejaculatory ducts. This sinus has fibro-muscular walls, lined by mucous membrane, on which open a number of small glands.

The *membranous* portion is between the prostate and the *bulb* of the urethra. This is the narrowest part of the tube except the orifice. From the projection of the bulb below it, it is three-quarters of an inch long on its concave roof, and half an inch along its convex floor. It passes through the deep perineal fascia; and is invested by a double extension from it, and by the *compressor urethræ* muscle.

The *spongy* portion is the longest, having a length of about six inches, to the *meatus urinarius.* Below the symphysis pubis it ascends a little, and then descends forward. It has an almost uniform diameter of a quarter of an inch; except in the *bulbous* portion, and in the *fossa navicularis* within the *glans penis*, in which localities it is dilated.

The *meatus* or orifice is the narrowest part of the canal; its direction is vertical, with two small elevations or *labia* at its sides.

The lining *mucous membrane* of the urethra has numerous small orifices of mucous glands and follicles, the *glands of Littré.* These openings are sometimes large enough (*lacuna magna*) to detain the end of a catheter. *Cowper's* glands open into the bulbous portion.

The *muscular* coat of the urethra is most abundant in its prostatic part. It consists of an outer longitudinal and an inner circular layer of unstriped fibres.

Prostate Gland.

In shape like a horse-chestnut, and composed of three lobes, this gland lies below and behind the symphysis pubis, around the neck of the bladder and urethra, and upon the rectum. Its transverse diameter at the base is an inch and a half; from before backwards an inch; depth, three-quarters of an inch.

Its lobes are the two *lateral* and the *middle* lobe. The middle lobe is normally only a transverse band behind the beginning of the urethra; sometimes it is absent. In old men it is frequently much enlarged.

The prostate gland is dense, though friable, and is surrounded by a fibrous capsule. It is perforated by the seminal ducts. Connected with it are circular, unstriped muscular fibres, around the urethra. Its *secretion* is a milky fluid in appearance, with an acid reaction.

Cowper's Glands.

These are two lobulated yellowish bodies, each as large as a pea, in front of and under the membranous portion of the urethra, behind the bulb. Their excretory ducts run for almost an inch obliquely forwards, to open into the bulbous part of the urethra.

Penis.

This organ consists of the *root*, *body*, and *gland*. The *crura* or fibrous branches connect the root of the penis with the *rami* of the pubes. By the suspensory ligament it is held to the front of the symphysis pubis.

The *glans* penis is of a rounded conical form, with the *meatus urinarius* at its extremity. Behind and below this is the *frænum præputii*, a fold of mucous membrane going backwards to join with the prepuce. The *corona glandis* is a round projecting border at the base of the gland; behind this is the narrowing called the neck or *cervix*. The sebaceous *glands of Tyson* (*glandulæ odoriferæ*) are located around the corona and cervix.

The *body* of the penis is covered by a loose thin tegument, which forms the *prepuce* by doubling upon itself at the neck of the gland.

Its internal layer, reflected from the cervix over the glans, is of the character of a mucous membrane.

The body of the penis is composed of three cylinders of fibrous and erectile tissue; the two *corpora cavernosa*, and the *corpus spongiosum.*

Each *corpus cavernosum* is composed of a strong fibrous coat, within which is a network of fibres, containing the vascular erectile tissue. The bands of fibres are called *trabeculæ.* Between the two *corpora* is a septum, most complete behind; in front it is comb-like or *pectiniform.*

In the fibrous outer coat and septum are numerous elastic and *muscular* fibres; some of the latter occur also in the *trabeculæ.*

The *corpus spongiosum* lies below the junction of the corpora cavernosa, inclosing the urethra. It commences between the *crura* of the penis, in the *bulb*, and terminates in the *glans.* The bulb is surrounded by the accelerator urinæ muscle.

The structure of the corpus spongiosum is essentially like that of the cavernosa, but with a thinner and more elastic envelope.

Erectile tissue is principally formed of a close plexus of small veins, freely communicating with each other. They are largest in size in the middle of each corpus cavernosum. Their blood is returned by the *vena dorsalis penis*, and by the prostatic and pudendal veins.

The *arteries* of the penis come from the internal pudic. The *helicine* arteries (whose existence is not universally admitted) are convoluted, tendril-like vessels, most abundant in the back part of the penis.

The *nerves* of the penis are branches of the internal pudic nerve and the hypogastric plexus. Its *lymphatics* are superficial and deep-seated; some going through the inguinal glands, and others joining the deep pelvic lymphatics.

Testes.

These are oval glands, suspended in the *scrotum* by the two *spermatic cords.* Behind each is a long and narrow body, the *epididymis;* of which the upper enlarged end (*globus major*) is connected by its ducts with the upper end of the testicle, and the lower end (*globus minor*) with its lower end and investing tunic. The left testicle is a little the largest.

The *coverings* of the testicle are, the *skin*, *dartos muscle*, *external spermatic fascia*, *cremaster muscle*, *fascia propria* or infundibuliform fascia, and *tunica vaginalis.*

The *dartos* is a thin loose layer of connective tissue mixed with unstriped muscular fibres.

The *cremaster muscle* consists of a few scattered bands of fibres of the internal oblique muscle, carried down in the descent of the testicle.

The *fascia propria* is a similar process of the fascia transversalis.

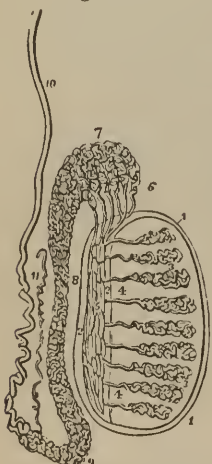
The *tunica vaginalis* is the serous investment of the testicle, derived from the peritoneum. It is duplicated, over the testis and within the scrotum, the outer layer extending above and below the testis, upon the cord.

The immediate *fibrous* covering of the testicle is the *tunica albuginea*. A partial septum formed by the vertical descent of this tunic into the gland is sometimes called the *corpus Highmorianum*, or *mediastinum* testis.

The *tunica vasculosa* is a plexus of bloodvessels lining the tunica albuginea for the supply of blood to the gland.

In structure, the testis is composed of from 250 to 400 *lobules*, of unequal size. Each lobule is conical, and formed of from one to three or four convoluted *tubuli seminiferi*. These may be unravelled; and are each several feet in length with a diameter from $\frac{1}{200}$th to $\frac{1}{150}$ of an inch; they number in all from 300 to 800. Each is surrounded by a plexus of minute capillaries. In the posterior apex of each lobule, the tubuli become almost straight, forming the *vasa recta*, twenty or thirty in number; each of which has a diameter of $\frac{1}{50}$th of an inch.

Fig. 57.



MINUTE STRUCTURE OF THE TESTIS.—1, 1. Tunica albuginea. 2, 2. Corpus Highmorianum. 3, 3. Tubuli seminiferi. 4. Vasa recta. 5. Rete testis. 6. Vasa efferentia. 7. Coni vasculosi, the globus major of the epididymis. 8. Body of the epididymis. 9. Its globus minor. 10. Vas deferens. 11. Vasculum aberrans.

The *vasa recta* anastomose as they ascend, forming the *rete testis;* at the upper end of which are given off from twelve to fifteen ducts, the *vasa efferentia*, which pass through the tunica albuginea to the epididymis. By their convolution and enlargement, in conical masses (*coni vasculosi*), they make the *globus major*. Opposite the bases of the cones (each of which is formed by a single duct, six or eight inches long) their ducts open into a single tube or duct, which is very much convoluted, forming the *globus minor* of the epididymis. The length of this tube when unravelled is more than twenty feet.

The *vas deferens* is the continuation of this duct, upwards from the globus minor, behind the epididymis, and on its inner side. It then goes along, in the *spermatic cord*, through the external and the internal abdominal rings, into the pelvis. Reaching the base of the bladder, it becomes enlarged, and then, narrowing at the prostate, joins the duct of the *vesicula seminalis* to form the *ejaculatory* duct. The vas deferens is a firm tube, about two feet long, with a canal $\frac{1}{24}$th of an inch in diameter. It has a cellular, muscular, and mucous coat.

Vesiculæ Seminales.

These are lobulated membranous pouches, one on each side, between the bladder and rectum. They are reservoirs for semen, besides having a secretion of their own which mixes with it. Each is about two and a half inches long by half an inch wide; but variable in these dimensions.

The *vesicula seminalis* is, in structure, a single tube, convoluted, and giving off irregular branches or *diverticula;* all being held together by fibrous tissue. The tube is of the diameter of a goose-quill, and from four to six inches long; behind, it ends abruptly, as a *cul-de-sac;* in front it is continued as a straight narrow duct, which joins with that of the vas deferens to make the ejaculatory duct.

Each ejaculatory duct (one on each side) is about $\frac{3}{4}$ths of an inch in length. It commences at the base of the prostate gland, and runs upwards and forwards through its substance, to open into the *sinus pocularis* of the prostatic part of the urethra.

Spermatozoa are minute filaments, found in the liquid of the *semen masculinum* formed in the testis. Each has an oval enlargement at one end, and a caudal prolongation or extremity; which shape, with their undulatory movements, suggested the erroneous idea of their being animalcules. Semen also contains, as shown by the microscope, *seminal granules*, $\frac{1}{4000}$th of an inch in diameter.

Spermatic Cord.

This cord is composed of the vas deferens, three arteries, a plexus of veins, the spermatic plexus of nerves, and some large lymphatic vessels; besides connective tissue, and the cremaster muscle, and fascia. Its course is from the back of the testicle upward to the *external* abdominal ring (see *Hernia*), and through the inguinal or spermatic cord to the *internal* ring, by which it enters the abdominal cavity.

The *arteries* of the cord are the *spermatic*, *cremasteric*, and the *artery of the vas deferens.*

The *nerves* of the cord are derived from the ganglionic or sympathetic plexuses of the abdomen.

Descent of the Testes.

In early fœtal life, the testes are in the abdomen, below the kidneys. At the lower end of each is a cord, the *gubernaculum testis*, connected with the scrotum at its lowest part. In the seventh month of gestation, the testicle descends, in the line of the now shortening gubernaculum, through the *internal ring*, carrying with it a fold of peritoneum; then through the inguinal canal and external ring, to enter the scrotum in the course of the eighth month. Just before birth at full term, the peritoneal pouch is closed above; leaving its fundus to form the *tunica vaginalis testis.* In the female, the *round ligament of the uterus* takes a similar course to that of the *gubernaculum.* At an early period of embryonic life the ovaries and testes correspond in position.

ORGANS OF GENERATION IN THE FEMALE.

The *ovaries* are the *essential* female organs of reproduction, and the *uterus* is that of gestation. Accessory to these are the *Fallopian tubes* and the *external genital organs*, i. e., the *vagina* and its connected parts.

Ovaries.

Each ovary is an oval body, about an inch and a half long, three-quarters of an inch wide, and a third of an inch in thickness. It is situated in the posterior part of the broad ligament of the uterus, behind and below the Fallopian tube, on either side; covered by peritoneum, except on its anterior margin, which is attached to the broad ligament. It has a fibrous coat, *tunica albuginea*, within which is a soft *stroma* or fibro-cellular structure well supplied with bloodvessels.

Fig. 58.

FEMALE PELVIC ORGANS, SEEN FROM ABOVE.—*a*, *a*. Obliterated hypogastric arteries. *b*. Broad ligament of uterus. *e*. Posterior ligaments of uterus. *g*. Ureter. *h*, *h*. Ovarian vessels. *m*. Linea alba and section of urachus. B. Bladder. L. Round ligament of uterus. F. Fimbriated extremity of Fallopian tube. T. Fallopian tube. O. Ovary. R. Rectum. U. Uterus. V. Fifth lumbar vertebra.

Graafian vesicles are from five to twenty small, round, transparent sacs, contained in the ovary. Each, before maturation, holds an *ovum*, $\frac{1}{180}$ of an inch in diameter, on the average, surrounded by clear fluid. As it matures, each Graafian vesicle enlarges, approaches the surface of the ovary, and finally bursts; the ovum then escapes through the Fallopian tube into the uterus, and, unless impregnated, is discharged with the menstrual fluid.

Corpus luteum is the name given to the remains of the Graafian vesicle, after its maturation and the discharge of the ovum. Those left *after pregnancy* are peculiar, and are called *true corpora lutea;* those formed at other times, *false*. The former are larger, firmer, yellower, more vascular, and more puckered in appearance.

The *ligament of the ovary* extends from the upper angle of the uterus to the inner end of the ovary.

The *round ligaments* are two cords, each four or five inches long, below and in front of the Fallopian tube, between the layers of the broad ligament. Each passes from the upper angle of the uterus, forward and outwards, through the internal abdominal ring, and along the inguinal canal, to be lost upon the labia majora.

Fallopian Tubes.

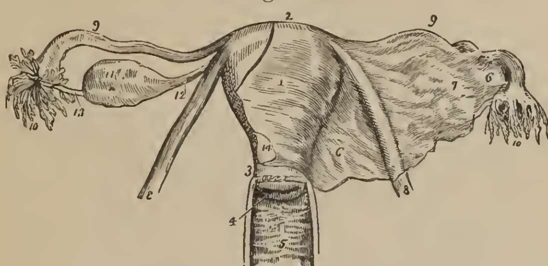
These are two oviducts, one on each side, lying in the free margin of the broad ligament. Each is about four inches long, with a very minute canal, which widens near its outer end, trumpet-like, and then contracts at its termination. The inner end, *ostium internum*, communicates with the uterus ; the outer, *ostium abdominale*, opens into the cavity of the abdomen. The latter is *fringed*, and is called the *fimbriated* extremity of the Fallopian tube. It is believed to embrace the ovary during sexual excitement.

The Fallopian tube has a *serous*, *muscular*, and *mucous* coat.

Uterus.

The womb, in the virgin, is pear-shaped, flattened before and behind. It is suspended between the bladder and the rectum, by six ligaments of peritoneum. It is about three inches long, two wide at its upper part, and an inch thick. Its upper end is directed upwards and forwards ; its lower end, downwards and backwards, forming an angle with the vagina. Its parts are the *fundus*, *body*, and *neck* or *cervix*.

Fig. 59.



UTERUS AND ITS APPENDAGES.—1. Body of uterus. 2. Fundus. 3. Cervix. 4. Os uteri. 5. Vagina. 6. Broad ligament. 7. Position of ovary. 8. Round ligament. 9. Fallopian tube. 10. Fimbriated extremity of Fallopian tube. 11. Ovary. 12. Ligament of the ovary. 13. Fallopio-ovarian ligament. 14. Peritoneum on anterior surface of uterus.

The *fundus* is the broad base or upper part ; the body narrows from the fundus to the neck. The *cervix* communicates with the vagina, which is attached around it, extending upwards farther behind than in front. The *os uteri* or *os tincæ* is the mouth of the uterus, opening into the cavity of the vagina. Obstetricians speak also of the *os internum*, at the upper end of the constriction called the cervix. The cavity of the unimpregnated uterus is

quite small. The coats of the uterus are three: *serous*, *muscular*, and *mucous;* the last being its inner lining. It is covered by ciliated columnar epithelium. Numerous follicles and glands exist in the cervix. When distended with fluid, they have been called *ovula Nabothi.*

Ligaments of the Uterus.—Two anterior ligaments, or semilunar peritoneal folds, pass between the cervix of the uterus and the posterior surface of the bladder.

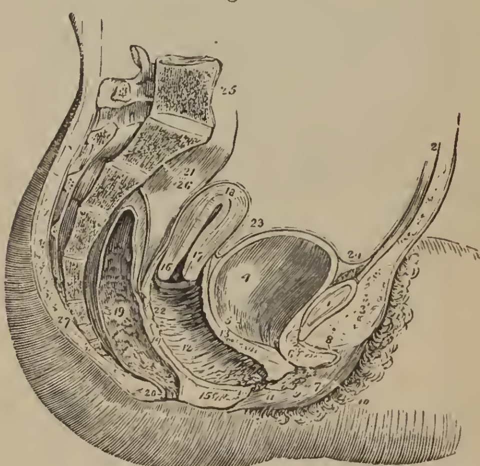
Two posterior ligaments, also folds of peritoneum, connect the sides of the uterus with the rectum.

The *two broad* ligaments extend from the sides of the uterus to the walls of the pelvis, dividing its cavity into an anterior and a posterior portion. The former contains the bladder, urethra, and vagina; the latter, the rectum. The broad ligaments are connected with the peritoneum, and correspond essentially with it in structure.

Vagina.

This is a musculo-membranous canal, about four inches in length along its anterior wall, longer posteriorly; curved in its direction

Fig. 60.



VISCERA OF FEMALE PELVIS.—1. Symphysis pubis. 2. Abdominal parietes. 3. Mons veneris. 4. Bladder. 5. Entrance of ureter. 6. Urethra. 7. Meatus urinarius. 8. Clitoris. 9. Left nympha. 10. Left labium majus. 11. Orifice of vagina. 12, 22. Vaginal canal. 13. Wall between vagina and rectum. 15. Perineum. 16. Os uteri. 17. Cervix. 18. Fundus. 19. Rectum. 20. Anus. 21. Upper part of rectum. 23. Fold of peritoneum. 24. Reflexion of peritoneum. 25. Last lumbar vertebra. 26. Sacrum. 27. Coccyx.

downwards and forwards from the uterus. Its outlet is called the *vulva.* It consists of an *external muscular*, a *middle erectile*, and an

internal mucous coat. The last presents two longitudinal (anterior and posterior), and numerous transverse ridges or *rugæ;* also many conical and filiform papillæ, besides mucous glands and follicles, especially at its upper part.

The *pudendum* is a term applied to the vulva and its appendages. The *mons veneris* is the rounded fatty prominence over the pubes in front, covered with hair after puberty. The *labia majora* are longitudinal folds, one on each side of the vulva; reaching from the mons veneris to the perineum. Externally, each is formed of integument; within, of mucous tissue. The two labia are joined in front and behind, by the anterior and posterior *commissures.* Just within the latter is a small transverse fold, the *fourchette.* Between it and the posterior commissure is the *fossa navicularis.*

The *labia minora* or *nymphæ* are smaller mucous folds, within the *majora;* they pass obliquely from the clitoris above to the sides of the vagina below. The *clitoris* is a small erectile organ, analogous to the penis of the male in its cavernous structure. It is situated just above the vagina. The *hymen* is a thin semilunar fold of mucous membrane, across the lower part of the orifice of the vagina. As it is, occasionally, congenitally absent, and has been known to be present in prostitutes, it is not, as was formerly supposed, a test of virginity. Usually, after its rupture, small rounded elevations are left around the orifice of the vagina, called *carunculæ myrtiformes.*

Urethra in the Female.

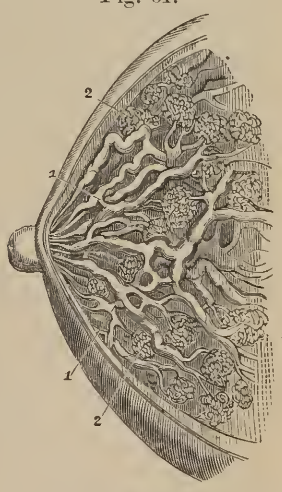
This canal is much shorter than in the male; having an average length of an inch and a half. Its direction, also, is different; being upwards and slightly backwards, with very little curve, behind the pubes. Its external orifice or *meatus* is in the small triangular space (*vestibule*), between the clitoris and the upper end of the vagina.

Mammary Glands.

These, as organs of nutrition for offspring, are accessory to the organs of reproduction. In the male they exist, but undeveloped.

In the female, each *mamma* is a true multi-lobular gland. The smallest lobules consist of clusters of rounded vesicles, opening into the smallest branches of the lactiferous (milk-bearing) ducts. These unite into larger ducts, finally making from fifteen to twenty (*tubuli lactiferi*, or *galactophori*), which converge towards the *areola* around the nipple. There they enlarge and form reservoirs for

Fig. 61.



SECTION OF MAMMARY GLAND. —1, 1. Galactophorous ducts. 2, 2. Lobuli.

the milk; and then run from the base of the nipple to its summit, where they perforate it with narrow orifices, by which the milk escapes under pressure. The nipple has a somewhat erectile structure.

CHAPTER VI.

ORGANS OF CIRCULATION.

HEART.

The heart is a hollow conoidal muscular organ enveloped by the pericardium, and suspended by its great vessels between the lungs.

It is situated behind the lower two-thirds of the sternum, its base above and apex pointing downward and to the left side. Its extent is from the level of the upper border of cartilage of the third rib to the space between the fifth and sixth ribs. It is about five inches long, in the adult, by three and a half inches of width in its broadest part, and two and a half inches in thickness. In the male, it weighs from ten to twelve ounces; in the female, from eight to ten. It increases in size and weight, however, to old age.

The heart is essentially twofold, being divided by a muscular septum into the *right* and *left*, or *respiratory* and *systemic* heart; conjoined, but not communicating after birth. Each half consists of an *auricle* and a *ventricle*. The auricles (named from an ear-like appendage belonging to each) are comparatively thin and weak, the ventricles thick and strong; their internal capacity is about the same, two fluidounces for each cavity. The auricles are above the ventricles. Most of the anterior surface of the heart is formed by the right ventricle, the left making the apex and left border; most of the posterior surface is made by the left ventricle.

The right auricle is a little larger than the left. It consists of a *sinus* or main cavity, and an *auricular appendix*.

The *ascending* and *descending venæ cavæ* both open into the right auricle. Between their terminations, on the right wall of the auricle, is a small projection, the *tuberculum Loweri*.

The *coronary veins*, the largest being sometimes called the *coronary sinus*, open into the right auricle, bringing blood from the substance of the heart. The apertures of the smaller veins are the *foramina Thebesii*. At the mouth of the coronary sinus is the *valve of Thebesius;* sometimes it is double.

Between the front margin of the ascending vena cava and the auriculo-ventricular opening (*ostium venosum*), is the *Eustachian valve*, large in the fœtus, small in the adult; it is semilunar, the free edge being concave.

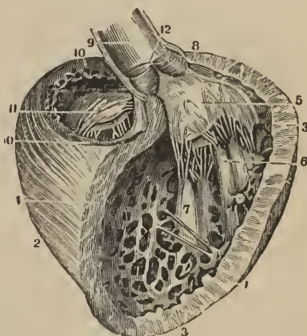
The *fossa ovalis* is a depression marking the place of the *foramen ovale* in the fœtus, between the right and left auricle. The prominent margin of it is the *annulus ovalis*.

The *musculi pectinati* are comb-tooth-like fleshy columns, which

cross the inner part of the auricular appendix and the contiguous portion of the wall of the auricle.

The *right ventricle* is triangular. It rests below and behind upon the diaphragm. It is separated from the left ventricle by a septum which bulges into the right ventricle. Above, it ends in a small cone (*conus arteriosus*); in which the pulmonary artery begins by a circular opening, guarded by three pocket-like *semilunar valves*. Each of these pockets is a fold of the lining membrane of the heart, with fibres of ligamentous tissue. At its most prominent part is the *corpus Arantii*, a small cartilaginous prominence, which completes the closure of the valves. Behind each valve is a pouch or dilatation; these are the *sinuses of Valsalva*.

Fig. 62.



The Left Ventricle.—1. Outer side of left ventricle. 2. Outer side of right ventricle. 3. Thickness of its outer parietes. 4. Thickness near the right ventricle. 5. Mitral valve. 6, 7. Columnæ carneæ with their chordæ tendineæ. 8. Origin of the aorta. 9. Cavity of the aorta. 10, 10. Superior surface of the right ventricle, showing the ostium venosum and tricuspid valve. 11. Tricuspid valve. 12. Semilunar valves of the aorta.

The *columnæ carneæ* are round muscular columns, which project from nearly the whole of the inner wall of the ventricle. Some project only as ridges, others are free except at the ends, while three or four of them give attachment to the *chordæ tendineæ*.

These, the tendinous chords, are connected with the free surfaces and margins of the three segments of the *tricuspid* or right auriculo-ventricular valve.

The tricuspid valve is a fold of the lining membrane of the heart, strengthened by fibrous tissue. Its upper margin is attached to the roof of the ostium venosum.

The *left auricle* is cuboidal in form, somewhat smaller but thicker than the right. In structure it resembles the right auricle; having a *sinus*, *auricular appendix*, and *musculi pectinati*. The *four pulmonary veins* open into it.

The *left ventricle* is more conical and longer than the right; its walls are about twice as thick, except near the apex.

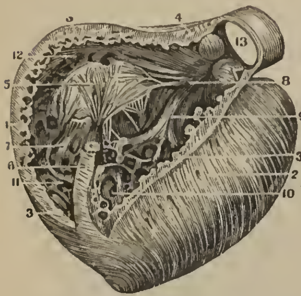
The *aorta* opens from this ventricle by a circular orifice, guarded by three *semilunar valves*, like those of the pulmonary artery, but with larger *corpora Arantii*, and deeper *sinuses of Valsalva*.

The *columnæ carneæ* of the left ventricle resemble those of the right; two of them, only, connect with *chordæ tendineæ* which are attached to the auriculo-ventricular valve.

This valve, the *mitral* valve, consists of but two unequal segments; but is larger and thicker than the tricuspid. Generally two lesser segments also exist at the place of union of the greater. In structure this valve is similar to the tricuspid.

The lining membrane of the heart, the *endocardium*, is a smooth, thin serous membrane, thickest in the auricles. It covers the valves, and is continuous with the inner coat of the bloodvessels.

Fig. 63.



INTERIOR OF THE RIGHT VENTRICLE.—1. Section of the parietes of the right ventricle. 2. Left ventricle. 3. Thickness of the parietes of the right ventricle. 4. Thickness at the commencement of the pulmonary artery. 5. Anterior fold of the tricuspid valve. 6. A portion of the right ventricle. 7, 8. Columnæ carneæ with their chordæ tendineæ. 9. Ventricular septum. 10, 11. Cavities between the bases of the columnæ carneæ. 12. Depression leading to the pulmonary artery. 13. Interior of the pulmonary artery.

The *muscular fibres* of the heart are intricately arranged; those of the auricles and those of the ventricles being mutually independent.

The fibres of the *auricles* are in two layers, the *superficial transverse* and the *deep;* the latter being in part *looped*, and in part *annular*. The superficial are common to *both* auricles, the deep are peculiar to *each*.

The *ventricles* also have fibres common to both, and some which are peculiar to each ventricle. The latter are the most common near the base of the heart.

The *superficial* fibres are mostly *spiral* in their direction, and placed in layers of unequal thickness. Coiling inwards at the apex of the heart, they there form the *vortex*, and thence ascend again. The *deep* fibres are circular in this direction.

Fibrous rings surround and give fixity to the auriculo-ventricular and arterial openings of the heart. Those of the left side are the strongest.

The heart is supplied with blood for its nutrition by the *two coronary arteries*, anterior and posterior. It has also *lymphatic* vessels.

The *nerves* of the heart are derived from the *cardiac plexus*, which is partly ganglionic or sympathetic, and partly cerebro-spinal in origin. Minute examination displays a great number of small ganglia on the surface and in the substance of the heart.

Pericardium.

This sac, which envelops the heart, is composed of an outer *fibrous* and an inner *serous* membrane. The *fibrous* coat is attached, below, to the diaphragm. At the base of the heart, it is extended for some distance over the *aorta*, *pulmonary artery*, *pulmonary veins*, and *descending vena cava; not* upon the *ascending* vena cava. In front, the pericardium lies close to the sternum, covered at the sides by the edges of the lungs, particularly the left. At its sides the pleuræ cover it, with the phrenic nerve and vessels between them on each side. Behind, the pericardial sac rests

against the bronchial tubes, the descending aorta, and the œsophagus.

The *serous* coat of the pericardium is double; one layer adhering to the heart, the other lining the fibrous sac. It extends more completely around the aorta and pulmonary artery than around the other great vessels of the heart. Its surface is smooth and moistened with serum.

For the route of the *circulation of the blood*, see PHYSIOLOGY.

ARTERIES.

Aorta.

This, the main trunk of all the arteries of the body, ascends from the upper part of the left ventricle for a short distance, and then forms an arch backwards over the root of the left lung. Thence descending upon the left side of the spinal column, it passes through the diaphragm into the abdomen; and finally divides, opposite to the fourth lumbar vertebra, into the right and left primitive or common iliac arteries. It may be divided in description into the *arch* of the aorta, the *thoracic* and the *abdominal* aorta.

The *arch* extends to the lower part of the third dorsal vertebra. Its ascending portion is included in the pericardium. The descending vena cava is to the right of it, the pulmonary artery to its left. Below the transverse part of the arch is the left bronchus and the bifurcation of the pulmonary artery. Behind it are the trachea, œsophagus, and thoracic duct.

Five branches go off from the arch of the aorta. From the ascending part, the *right* and *left coronary* arteries. From the transverse portion, the *arteria innominata*, *left carotid*, and *left subclavian*.

In *structure*, the aorta, like all the other arteries, has an *external* coat of connective and fibrous tissue; a *middle* coat, of muscular, elastic, and connective tissue; and an *internal* coat, of elastic serous membrane. The *muscular* fibres of the middle coat are chiefly transverse; they are of the *unstriped* variety, pale in color, and with spindle-shaped cells and persistent nuclei. The proportionate amount of muscular tissue is greatest in the *smallest* arteries, at a distance from the heart. Branches leave arteries generally at an acute angle; but this is variable. *Anastomosis* is the free communication which often occurs between two arteries. All arteries have their own nutritious vessels, or *vasa vasorum*.

Pulmonary Artery.

This vessel conveys *venous* or un-aired blood from the heart to the lungs, for aeration. It is about two inches long, chiefly inclosed in the pericardium; arising in front of the aorta, from the left side of the top of the right ventricle, and passing obliquely upward and backward and to the left, under the arch of the aorta, where it divides into the nearly equal *right* and *left* pulmonary arteries. The *right* pulmonary is rather the larger and longer. This, at the root of the right lung, divides into two branches, one for the upper and middle lobes, and the other and larger, the

lower lobe. The *left* pulmonary artery also ends in two branches, one for each lobe of the left lung. Each of these subdivides into a multitude of ramifications, interpenetrating at last the lobules of the lungs with extremely fine networks of capillaries, for aeration of the blood by the air-cells.

Coronary Arteries.

The *right* coronary arises from the aorta just above its valve, and passing in a groove between the right auricle and ventricle, curves around the back of the heart to the posterior groove between the ventricles. There it divides into two branches, which supply the substance of the heart, and anastomose with the branches of the left coronary artery.

The *left* coronary is smaller. It arises above the origin of the right, and descends to the anterior interventricular groove, where it divides, one branch continuing down the groove to the apex, the other winding around to the back of the heart.

Innominata.

This, the largest branch of the arch of the aorta, arises near the left carotid from its transvere portion, and, passing for an inch and a half to two inches obliquely up to the right sterno-clavicular junction, there divides into the right subclavian and right primitive carotid. To the right of the arteria innominata lie the vena innominata, and pneumogastric nerve; behind, it crosses the trachea.

Primitive or Common Carotids.

The *right* carotid arises from the innominata; the left, from the summit of the arch of the aorta. The latter is thus the longer.

Both passing upwards to the neck, their course is thereafter similar. At the level at the top of the thyroid cartilage, each divides into the *internal* and *external* carotid. The common carotids are separated at the lower part of the neck only by the trachea; above, by the pharynx, larynx, and thyroid gland.

In the same fascial sheath with the common carotid, are included the pneumogastric nerve, and, outside of that, the internal jugular vein; each having also its special sheath.

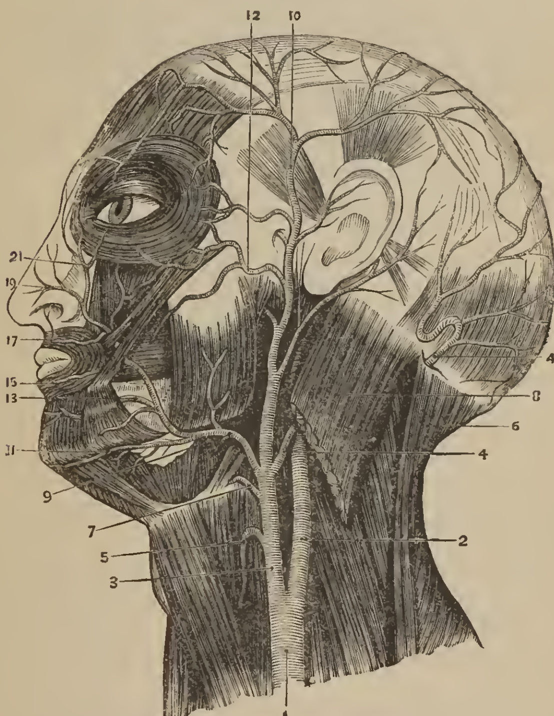
Below, the common carotid lies deeply, having over it the *superficial fascia*, *platysma myoides muscle*, the *deep fascia*, the *sterno-cleido-mastoid*, *sterno-hyoid*, *sterno-thyroid*, and, by the cricoid cartilage, the *omo-hyoid* muscles. Near its bifurcation above, it is bounded within a triangular space, *behind* which is the *sterno-cleido-mastoid*, *above*, the belly of the *digastric* muscle, and *below*, the *omo-hyoid*. A small artery and several veins cross it, and the *descendens noni* nerve lies upon or within its sheath. The *sympathetic* nerve is behind it, between it and the *rectus anticus major* muscle, which rests upon the spine.

At the lower part of the neck, the internal jugular vein of the right side leaves the artery; but that on the left side comes near to and often crosses it.

External Carotid.

From the division opposite the top of the larynx, this vessel curves upwards and forwards and then backwards, to divide between the neck of the condyle of the lower jaw and the external *meatus* or orifice of the ear, into the *temporal* and *internal maxillary* arteries.

Fig. 64.



THE ARTERIES OF THE FACE AND HEAD.—1. Common carotid. 2. Internal carotid. 3. External carotid. 4, 4. Occipital artery. 5. Superior thyroid artery. 6. Trapezius. 7. Lingual artery. 8. Sterno-mastoid. 9. Facial artery. 10. Temporal artery, dividing into anterior and posterior branches. 11. Submental branch. 12. Transverse facial artery. 13. Inferior labial branch. 15. Inferior coronary branch. 17. Superior coronary branch. 19. Lateral nasal branch. 21. Angular branch.

At its beginning, the external carotid has *behind* it the *sterno-cleido-mastoid* muscle; *below*, the *omo-hyoid;* and *above*, the *digastric* and *stylo-hyoid* muscles. The *hypoglossal* nerve and *lingual*

and *facial veins* cross it, as well as the *digastric* and *stylo-hyoid* muscles. It is *covered*, under the skin, by the *platysma myoid* muscle, the *deep fascia*, and the front edge of the *sterno-cleido-mastoid*.

Above, the external carotid passes into the substance of the *parotid gland;* lying there under the *facial* nerve, and the union of the internal maxillary and temporal veins. Between it and the internal carotid is part of the parotid gland, as well as the *stylo-glossus* and *stylo-pharyngeus* muscles.

Eight branches leave the external carotid artery; divisible into four sets, as follows: *Anterior*, the *superior thyroid*, *lingual*, and *facial; posterior*, the *occipital* and *posterior auricular; ascending*, the *ascending pharyngeal*; and *terminal*, the *temporal* and *internal maxillary*. Deviations or variations may occur (*as in all parts of the arterial system*) in the origin and distribution of these vessels; it is their *normal* or most general course that is described.

Superior thyroid curves upwards and then down to the thyroid gland; dividing into four branches also, the *hyoid*, *superficial descending*, *laryngeal*, and *crico-thyroid.*

Lingual ascends inwards to the greater cornu of the *os hyoides*, and, reaching the tongue, gives off the *hyoid*, *dorsalis linguæ*, *sublingual*, and *ranine* branches; the latter going to the tip of the tongue.

Facial is a tortuous vessel, which, passing up through the submaxillary gland, then crosses the margin of the lower jaw-bone, in front of the insertion of the masseter muscle; thence it goes across the cheek and up the side of the nose to the inner angle of the eye. Branches of the facial are ten in number; of which the principal are the *submaxillary*, *submental*, *inferior labial*, *superior* and *inferior coronary* (around the lips), and the *lateral nasal* artery. Muscular branches also go to the masseter and other muscles.

Occipital arises opposite to the facial, and passes behind the mastoid process, and thence upwards tortuously upon the occiput to divide about the vertex into many branches. Not far from its origin the hypoglossal nerve winds around it.

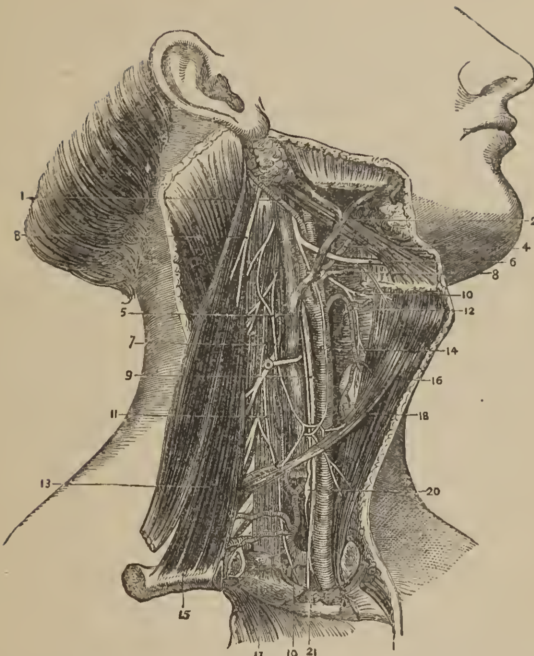
Posterior auricular is small; it goes beneath the parotid gland between the ear and the mastoid process; then dividing into the anterior and posterior branches, which anastomose with the temporal and occipital; also giving off the *stylo-mastoid* branch to the foramen of that name, and the *auricular* to the ear and lesser branches.

Ascending pharyngeal is yet smaller but long, and deeply-seated. It ascends between the internal carotid and the pharynx. Its branches are *muscular* and *nervous*, *pharyngeal* and *meningeal*. The latter pass through foramina in the base of the cranium to the dura mater.

Temporal appears as a continuation upwards of the external carotid, from the parotid gland. Two inches above the zygomatic arch it divides into the *anterior* and *posterior* temporal; first giving off the *transverse facial*, *anterior auricular*, and *middle temporal*.

Internal maxillary is larger than the temporal. It goes inwards at right angles to the latter, within the condyle of the lower jaw-bone; having three sets of branches: 1. from the *maxillary* part,

Fig. 65.



The Side of the Neck.—1. Occipital artery. 2. Facial vein. 3. Spinal accessory nerve. 4. Facial artery. 5. Internal jugular vein. 6. Hypoglossal nerve. 7. Communicans noni nerve. 8. Lingual artery. 9. Pneumogastric nerve. 10. Superior laryngeal nerve. 11. Phrenic nerve. 12. Superior thyroid artery. 13. Sterno-cleido-mastoideus (reflected). 14. Common carotid artery with descendens noni nerve. 15. Inner end of clavicle (reflected). 16. Sterno-hyoid. 17. Subclavian vein (cut). 18. Omo-hyoid. 19. Subclavian artery giving off the thyroid axis and the internal mammary artery. 20. Inferior cervical ganglion of sympathetic. 21. Apex of pleura.

tympanic, *middle meningeal*, *small meningeal*, and *inferior dental;* 2. from the *pterygoid* part, *deep temporal*, *pterygoids*, *masseteric*, and *buccal;* 3. from the *terminal* part, *alveolar*, *infra-orbital posterior palatine*, *vidian*, *pterygo-palatine*, and *nasal* or *spheno-palatine.*

Internal Carotid.

From the border of the thyroid cartilage this vessel ascends vertically to the carotid *foramen* in the petrous part of the temporal bone. Entering this, it soon winds forwards and inwards through the carotid *canal*, and then, near to the anterior clinoid process of the sphenoid bone, it pierces the dura mater and subdivides into branches.

These are, the *tympanic*, *anterior meningeal*, *ophthalmic*, *anterior cerebral*, *middle cerebral*, *posterior communicating*, and *anterior choroid*.

The *ophthalmic* enters the orbit with the optic nerve, through its foramen, and getting on the inner wall of the orbit, passes to the inner angle of the eye, where it divides into the *frontal* and *nasal* branches.

Other branches of the ophthalmic are, the *lachrymal*, *supra-orbital*, two *ethmoidal*, *palpebral*, three *ciliary*, and the *central artery of the retina*.

The *supra-orbital* is largest of these ; it runs through the supra-orbital foramen of the frontal bone. The *nasal* artery anastomoses with the terminal branch of the facial.

The *anterior cerebral* artery, leaving the internal carotid at the base of the brain (near the fissure of Sylvius), runs forwards in the fissure between the cerebral hemispheres ; the *two* anterior cerebral, right and left, having a short connecting trunk, the *anterior communicating* artery. Then they curve over the front edge of the corpus callosum, and upon its upper surface, to connect with the posterior cerebral.

The *middle cerebral* is larger. It goes obliquely outwards along the fissure of Sylvius, in which it divides into three branches.

The *posterior communicating* artery runs back from the internal carotid to anastomose with the posterior cerebral.

The *anterior choroid* goes to the choroid plexus, and the parts of the brain near it.

Subclavian Artery.

On the *right* side, the subclavian comes from the *innominata;* on the *left*, from the *aorta*. For a short distance, they differ ; then, their description becomes the same.

The *right* subclavian passes from its origin opposite the sterno-clavicular articulation upwards and outwards to the inner edge of the *scalenus anticus* muscle. It is here covered, in *front*, by the *skin*, *superficial fascia*, *platysma myoides*, *deep fascia*, *sterno-cleido-mastoid* muscle, *sterno-hyoid* and *sterno-thyroid* muscles. The internal jugular and vertebral veins *cross* it ; as also do the pneumogastric, phrenic, and some branches of the sympathetic nerves. *Beneath* it is the pleura ; *behind* it, the longus colli muscle, the sympathetic, and the transverse process of the third cervical vertebra. The recurrent laryngeal winds around its lower part.

The *left* subclavian arises opposite the second dorsal vertebra, from the transverse portion of the arch of the aorta ; and ascends to the first rib, behind the insertion of the scalenus anticus muscle. In *front* of it are the pleura, left lung, pneumogastric and phrenic nerves and cardiac branches of the sympathetic, left carotid artery, left internal jugular and innominata veins, sterno-hyoid, sterno-thyroid, and sterno-cleido-mastoid muscles. *Behind* it, the œsophagus, thoracic duct, inferior cervical ganglion of the sympathetic, longus colli muscle, and spinal column. *Outside* of it is the pleura ; on its *inner* side, the œsophagus, trachea, and thoracic duct.

Reaching the scalenus anticus muscle, and passing over the first rib between that muscle and the scalenus medius, the right and left

subclavian arteries thenceforth have the same course; both being, like other vessels, subject to occasional variation or anomaly.

The most superficial part of the subclavian lies in a triangle, whose base in front is the scalenus anticus; one side above, being the omo-hyoid muscle, and the other the clavicle, below. The external jugular vein crosses it on the inner side, receiving there two venous branches. The subclavian vein lies below the artery, behind the clavicle.

The *four branches* of the subclavian artery are, the *vertebral*, *internal mammary*, *thyroid axis*, and *superior intercostal.*

Vertebral Artery.

This, the largest branch of the subclavian, enters the foramen in the transverse process of the *sixth* cervical vertebra, and passes through the corresponding foramina of the upper five vertebræ, to enter the head through the foramen magnum occipitis. In front of the medulla oblongata it forms, by union with the opposite one, the *basilar* artery. Before this, it gives off *lateral spinal* and *muscular* branches. Within the cranium, the vertebral sends off the *posterior meningeal*, *anterior* and *posterior spinal*, and *inferior cerebellar.* The last is the largest.

The *basilar* artery extends from the posterior to the anterior border of the pons Varolii; there it divides into the two *posterior cerebral* arteries. On each side it gives off the *transverse*, *anterior*, and *superior cerebellar.*

The *circle of Willis* is the anastomosis, at the base of the brain, between the basilar artery and the internal carotid and its branches.

Thyroid Axis.

This is a large but short vessel, dividing into the *inferior thyroid*, *supra-scapular*, and *transversalis colli.*

The *inferior thyroid* goes to the thyroid gland, giving off as branches the *laryngeal*, *tracheal*, *œsophageal*, and *ascending cervical.* The *supra-scapular* and *transversalis colli* have principally a muscular distribution.

Internal Mammary.

This artery descends from the subclavian behind the clavicle to the inner surface of the costal cartilages, near the sternum; between the sixth and seventh cartilages, it divides into the *musculo-phrenic* and *superior epigastric.* Besides these, its branches are the *superior phrenic*, *mediastinal*, *pericardiac*, *sternal*, *anterior intercostal*, and *perforating* arteries.

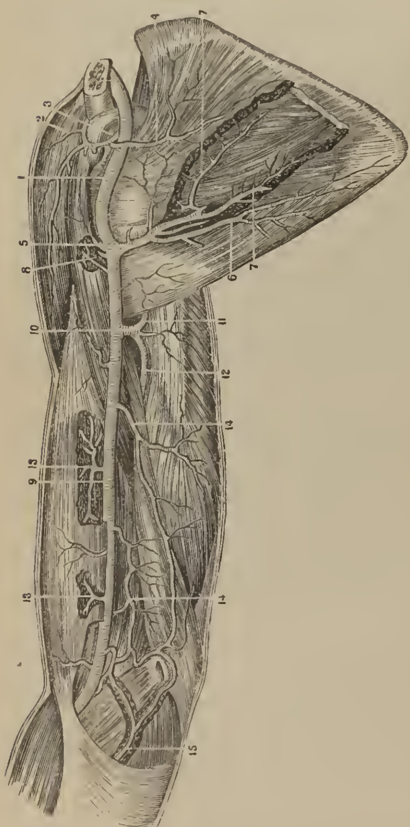
Superior Intercostal.

Last branch of the subclavian, this goes backwards, sending off the *deep cervical* to descend in front of the first and second ribs, at their necks, and anastomoses with the first aortic intercostal. It sends a branch also along the first intercostal space, and one for the second, which joins the aortic branch. Each of these sends branches to the spinal cord.

Axillary Artery.

As the continuation of the subclavian, this vessel passes from the lower edge of the first rib, to become the *brachial* as it passes the border of the tendons of the latissimus dorsi and teres major muscles. Very deep at first, it is afterwards almost superficial.

Fig. 66.



In the former position, it has in *front* of it the pectoralis major muscle, costo-coracoid fascia, and cephalic vein. *Behind* it, the first intercostal muscle, serratus magnus muscle, and posterior thoracic nerve. *Outside* of it is the brachial nervous plexus. *Inside* of it, the thoracic vein.

Next, it passes under the pectoralis minor muscle, having, in *front*, also, the pectoralis major; *behind*, the subscapularis; *inside* of it, the axillary vein.

Lastly, the axillary lies still below the pectoralis minor, with the lower edge of the pectoralis major covering it, in *front*, only above; the the skin and fascia, only below. There, it has *behind* it the subscapularis muscle, and tendons of the latissimus dorsi and teres major; *outside* of it the median nerve, and, part way, the musculo-cutaneous nerve; on the *inner* side,

Arteries of the Arm and Shoulder.—1. Axillary artery. 2. Thoracica acromialis. 3. Thoracica superior. 4. Sub-scapularis branch. 5. Inferior scapular. 6, 7. Branches to the teres and sub-scapularis muscles. 8. Anterior circumflex. 9. Brachial artery. 10. Profunda major humeri. 11. Posterior circumflex. 12. Main trunk of the profunda major. 13. Muscular branches. 14. Branches to the brachialis internus. 15 Recurrens ulnaris anastomosing with the anastomotica of the brachial.

the ulnar, internal cutaneous and lesser internal cutaneous nerves; *behind*, the musculo-spiral and circumflex nerves.

Branches of the axillary are, first, the *superior thoracic* and *acromial thoracic;* secondly, the *thoracica longa* and *thoracica alaris;* lastly, the *subscapular* and *anterior* and *posterior circumflex* arteries.

The *thoracica longa* goes downwards and inwards to the muscles at the side of the chest. The *subscapular* is the largest branch of the axillary. The *circumflex* arteries wind around the neck of the humerus.

Brachial Artery.

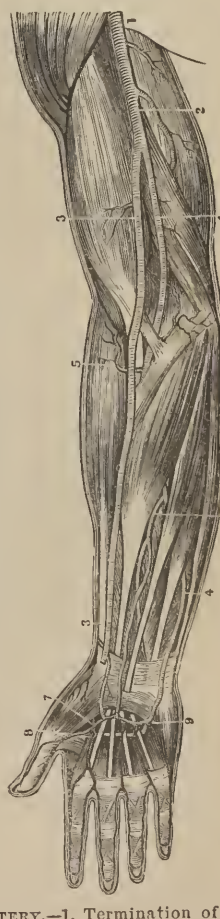
From the margin of the teres major tendon this passes down on the inside of the humerus, coming forward gradually near the elbow, to divide there into the *radial* and *ulnar* arteries. It is superficial throughout, covered in *front* by the skin and superficial and deep fasciæ; it has the basilic vein to lie near its line, the median nerve to cross its middle, and the bicipital fascia to separate it, near the elbow, from the median basilic vein.

Behind the brachial, the long and inner heads of the triceps extensor muscle, and the superior profunda artery and musculo-spiral nerve, come between it and the humerus. *Outside* of it, besides the median nerve, lie the biceps flexor and coraco-brachialis muscles; over the insertion of the latter of which, and the brachialis anticus, the bifurcation of the artery occurs. The place of this (bifurcation), however, is especially subject to anomaly.

Inside of the brachial are, above, the internal cutaneous and ulnar nerves; below, the median nerve. *Accompanying* it in its course, with crossing branches, are the two *venæ comites.*

It is, usually, opposite to the coronoid process of the ulna that the brachial, having sunk there into a triangular space, divides into the radial and ulnar. If deviation exist, it is, most frequently, *above* the normal point.

Fig. 67.



One of the Anomalies in the Brachial Artery.—1. Termination of the axillary artery. 2. Brachial artery. 3, 3. Radial artery. 4, 4. Ulnar artery. 5. A recurrent branch. 6. Anterior interosseous artery. 7. Superficial palmar arch. 8. Deep-seated palmar arch. 9. Anastomosis of the two arteries.

The branches of the brachial are, the *superior* or *major profunda*, *nutritious* artery, *profunda minor* or *inferior*, *anastomotic* and *muscular* branches.

Radial Artery.

Smaller, and more superficial than the ulnar, the radial passes along the outer side of the forearm, guarded by muscles and tendons; especially by the supinator radii longus and flexor carpi radialis. At the wrist, it winds around the carpus, under the extensor tendons of the thumb, to the interosseous space behind. Two *venæ comites*, and a filament of the musculo-cutaneous nerve, accompany the radial artery.

In the *forearm*, the branches of the radial are, the *radial recurrent*, *muscular*, *superficialis volæ*, and *anterior carpal.*

In the *wrist*, the *posterior carpal*, *metacarpal*, *dorsales pollicis*, and *dorsalis indicis.*

In the *hand*, the *princeps pollicis*, *radialis indicis*, *perforating*, and *interosseous* arteries. The *deep palmar arch* is the termination of the radial; it joins with a communicating branch of the ulnar.

Ulnar Artery.

This runs along the ulnar border of the forearm, becoming near the wrist more deep-seated than the radial; it ends in the palm of the hand by forming the *superficial palmar arch;* this anastomoses with the *superficialis volæ.*

The branches of the ulnar artery are, in the *forearm*, the *anterior* and *posterior ulnar recurrent*, the *anterior* and *posterior interosseous*, and muscular branches.

In the *wrist*, the *anterior* and *posterior carpal.* In the *hand*, the *communicating* or *deep* branch, and the *digital* arteries.

The *recurrent* arteries, both radial and ulnar, anastomose with vessels proceeding from above towards the hand.

The *digital* arteries are four; going off from the *superficial* palmar arch, to the *sides* of the index, middle, ring, and little fingers; lying beneath the digital nerves. At the middle of the last phalanx of each finger, an arch is formed by the meeting of these with the *interosseous* arteries, from the *deep* palmar arch. Branches from this anastomosis pass to the matrix of the finger nail.

Thoracic Aorta.

From the lower edge of the third dorsal vertebra, on the left side of the spinal column, the aorta descends to the diaphragm; which it penetrates near the last dorsal vertebra. This course is in the posterior mediastinum; having near it, the left lung, pleura, pulmonary artery, and bronchus, the pericardium and œsophagus, the thoracic duct, the vena azygos major and vena azygos minor.

Branches of the aorta in the thorax are, the *pericardiac*, *bronchial*, *œsophageal*, *posterior mediastinal*, and *intercostal.*

The *bronchial* arteries, various in number, usually one for the right side and two for the left, are the nutritious vessels for the lungs. They go to join and follow the bronchial tubes in their distribution.

The *intercostal* arteries are normally ten on each side, longest on the right. Going to the intercostal spaces, below the first, each divides into an anterior and a posterior branch; small fibrous arches protect these vessels from pressure by the intercostal muscles.

Abdominal Aorta.

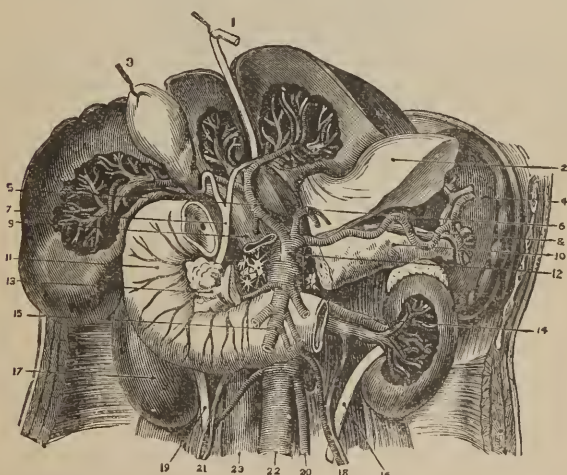
From the aortic opening in the diaphragm, the aorta goes down on the left side of the spinal column to the fourth lumbar vertebra. There it divides into the *right* and *left* common or *primitive iliac* arteries. The ascending vena cava lies to the right of it with the vena azygos, thoracic duct, and right semilunar ganglion; on its left are the sympathetic nerve and left semilunar ganglion.

The branches here are separable into, 1, *visceral;* and 2, *parietal*, *i. e.*, for the abdominal walls. The first are the *cœliac axis*, *superior* and *inferior mesenteric*, *supra-renal*, *renal*, and *spermatic*. The second group, the *phrenic*, *lumbar*, and *median sacral* arteries.

Cœliac Axis.

This arises near the margin of the diaphragm, and after a course of half an inch, divides into the *gastric*, *hepatic*, and *splenic arteries*.

Fig. 68.



Cœliac Axis.—1. Round ligament of liver. 2. Great end of stomach (cut). 3. Gall-bladder. 4. Spleen. 5. Hepatic artery. 6. Coronary [gastric] artery. 7. Common bile duct. 8. Splenic artery and vein. 9. Vena portæ. 10. Tail of pancreas. 11. Duodenum. 12. Cœliac axis. 13. Head of pancreas. 14. Left renal vessels. 15. Superior mesenteric artery. 16. Left ureter. 17. Right kidney. 18. Left spermatic vessels. 19. Right ureter. 20. Inferior mesenteric artery. 21. Right spermatic vessels. 22. Aorta. 23. Vena cava.

[The ganglia of the solar plexus are seen on each side of the aorta just below the cœliac axis.]

The *gastric* is smallest. It goes up, and to the left, to the cardiac end of the stomach, and then along its lesser curvature, some of its branches joining those of the hepatic and splenic; others go to the œsophagus.

The *hepatic* is next in size in the adult. It passes to the right side, into the transverse fissure of the liver, where it divides into a right and a left branch, whose ramifications accompany those of the portal vein into the substance of the liver. Its branches are the *pyloric*, *gastro-duodenal*, and *cystic*.

The *splenic* is a large and tortuous artery. Besides supplying the spleen, it sends blood to the cardiac end of the stomach, by the *vasa brevia* and the *gastro-epiploica sinistra*, and to the pancreas, by the *pancreatica magna* and *pancreaticæ parvæ*.

Superior Mesenteric.

By this vessel nearly the whole of the small intestine is supplied, as well as the cæcum and colon. Going between the pancreas and duodenum, it crosses and descends in an arched form to end in the right iliac fossa. The superior mesenteric vein and plexus of nerves accompany it. Besides a branch to the pancreas and duodenum, and twelve or more branches to the small intestine, it gives off also the *ileo-colic*, *colica dextra*, and *colica media*.

Inferior Mesenteric.

This branch of the aorta supplies the descending colon, its sigmoid flexure, and most of the rectum. It terminates in the *superior hemorrhoidal* artery, sending off, also, the *colica sinistra* and *sigmoid*.

The *superior hemorrhoidal* divides into small branches only when it has reached, at the posterior part of the rectum, a distance of about four inches from the anus.

Supra-renal Arteries.

These are, though large in the fœtus, small in the adult. There is one for the right and one for the left supra-renal capsule.

Renal or Emulgent Arteries.

Each kidney receives a large trunk from the aorta, leaving it almost at a right angle. The left one arises above the right, but the right is somewhat the longest. Before entering the kidney, each artery divides into several branches.

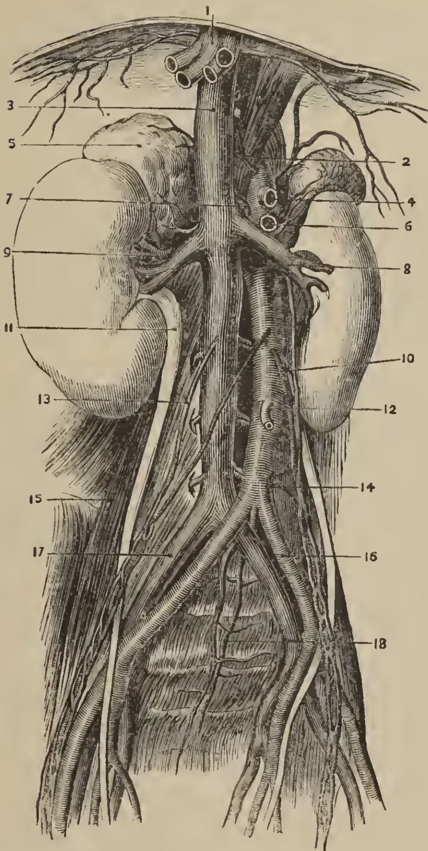
Spermatic.

In the male, this artery on each side goes to the testicle; in the female, to the ovary. It is longer in the male, and quite tortuous, attending the spermatic cord in its course through the abdominal rings.

Phrenic.

Varying a good deal in its origin, the *phrenic* artery chiefly supplies the diaphragm; some branches, however, going from it to the supra-renal capsule, the spleen on the left side, and the liver on the right.

Fig. 69.



ABDOMINAL AORTA AND VENA CAVA.—1. Hepatic veins (cut). 2. Phrenic arteries. 3. Vena cava. 4. Cœliac axis (cut). 5. Supra-renal capsule. 6. Superior mesenteric artery (cut). 7. Supra-renal artery. 8. Renal vein. 9. Renal artery. 10. Left spermatic vessels. 11. Right ureter. 12. Inferior mesenteric artery. 13. Right spermatic vein. 14. A lumbar artery. 15. Psoas magnus. 16. Common iliac artery (left). 17. Common iliac vein (right). 18. Middle sacral artery.

Lumbar Arteries.

Four of these go on each side, nearly at right angles from the aorta, and outwards and backwards, around the lumbar vertebræ. Between the transverse processes, each divides into an *abdominal* and a *dorsal* branch.

Middle Sacral Artery.

A small branch, from the bifurcation of the aorta, passing down in front of the last lumbar vertebra and the middle of the sacrum, to anastomose, about the upper end of the coccyx, with the lateral sacral arteries. Some of its ramifications go to the rectum, and others enter the anterior sacral foramina.

Common Iliac.

The primitive or *common iliac* artery, on each side, is about two inches in length, the right being somewhat the largest. They diverge from the aorta at the fourth lumbar vertebra, outwards and downwards, dividing, opposite the junction of the last lumbar vertebra and the sacrum, into the *external* and *internal* iliacs. Two common iliac veins accompany each. The lateral branches of the common iliac arteries are small and local.

Internal Iliac.

This is a short but thick artery, an inch and a half long. At the top of the great sacro-sciatic foramen, it divides into a large *anterior* and a similar *posterior* branch. From this bifurcation, the cord-like remainder of the *hypogastric* artery of the fœtus extends to the bladder. From the *anterior* trunk pass off, as branches, the *superior*, *middle*, and *inferior vesicle*, *middle hemorrhoidal*, *obturator*, *internal pudic*, and *sciatic;* and, in the female, the *uterine* and *vaginal* arteries. From the *posterior* trunk go the *gluteal*, *ilio-lumbar*, and *lateral sacral.*

The *middle hemorrhoidal* goes to the rectum; anastomosing with the other hemorrhoidal vessels.

The *obturator* artery sometimes arises from the *posterior* branch of the internal iliac; generally from the anterior. Passing out of the pelvis through the obturator foramen, it divides into an *internal* and an *external* branch. Its other branches are small.

The *internal pudic* supplies the external genital organs. Besides *muscular*, *nervous*, and *visceral* branches given off within the pelvis, it sends off, after its emergence through the great sacro-sciatic notch or foramen, the *inferior hemorrhoidal*, *superficial*, and *transverse perineal*, the *artery of the bulb*, the *artery of the corpus cavernosum*, and the *dorsalis penis.* Remark, however, that the internal pudic *re-enters* the pelvic cavity by the lesser sacro-sciatic foramen; afterwards, crossing to the ramus of the ischium, to ascend it and run along the inner margin of the ramus of the pubes. Its *terminal* branches are the artery of the corpus cavernosum and the dorsalis penis.

The *transverse perineal* artery accompanies the transversus perinei muscle.

Sciatic Artery.

This is the larger of the two terminal branches of the anterior trunk of the internal iliac; the internal pudic being the other.

The *sciatic* supplies the posterior muscles of the pelvis.

Gluteal Artery.

The gluteal is the largest branch of the internal iliac. Short and thick, it leaves the pelvis above the pyriformis muscle; then dividing into a *superficial* and a *deep* branch. The *superficial* passes under the gluteus maximus muscle, and subdivides. The *deep* branch goes between the gluteus medius and gluteus minimus muscles, and divides into two.

Ilio-Lumbar.

This branch of the posterior trunk of the internal iliac ascends beneath the psoas muscle and internal iliac artery and vein, to divide, in the iliac fossa, into a *lumbar* and an *iliac* branch.

Lateral Sacral.

These are commonly two on each side; the *superior* and the *inferior* lateral sacral, branches of the posterior trunk of the internal iliac.

External Iliac Artery.

Larger in the adult than the internal iliac, the *external iliac* artery passes downwards and outwards along the psoas muscle to the margin of the pelvis, half way between the anterior superior spine of the ilium and the symphysis pubes. There, emerging from the pelvis to enter the thigh, it becomes the *femoral artery*. At the femoral arch, the femoral vein lies at its inner side; the anterior crural nerve is outside and in front of it.

The most important branches of the *external iliac* are the *epigastric* and the *circumflex iliac.*

Epigastric Artery.

This vessel arises a few lines above Poupart's ligament (border of the tendon of external oblique muscle) and after a short descent it passes obliquely upwards and inwards between the transversalis fascia and the peritoneum, to the margin of the rectus abdominis muscle. Penetrating its sheath it ascends behind that muscle, subdividing, and anastomosing finally with branches of the internal mammary and intercostal arteries.

The branches of the *epigastric* artery are the *cremasteric*, *pubic*, and *muscular* branches.

The occasional *variations* in the origin of the epigastric are important in the surgical anatomy of hernia.

Circumflex Iliac.

Arising from the outside of the external iliac, nearly opposite to the epigastric, this artery runs to the crest of the ilium, to anastomose afterwards with the gluteal and ilio-lumbar arteries.

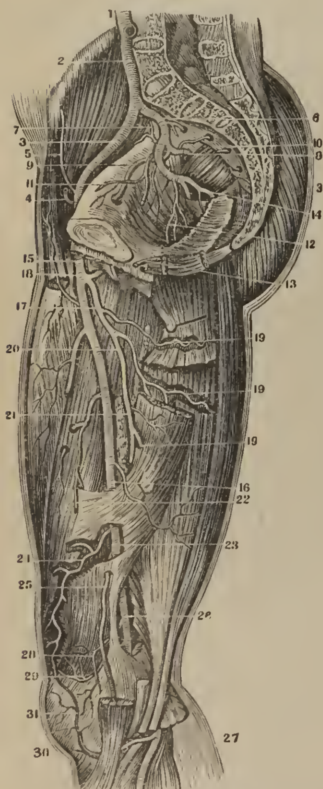
Femoral Artery.

This continuation of the external iliac, passing under Poupart's ligament down the front and inside of the thigh, runs, at the junction of the middle and lower third of the thigh, through an

opening in the adductor magnus muscle, to become the *popliteal* artery. Its course may be marked by a line drawn from a point half way between the anterior superior spine of the ilium and the symphysis pubis to the internal condyle of the femur; to which line the femoral artery lies parallel.

The *femoral* is superficial in the upper third of the thigh. Its location is there sometimes called *Scarpa's triangle.* The apex of this space is below; the inner side is the line of the adductor longus muscle, the outer, the sartorius muscle, and the base, Poupart's ligament. The iliacus, psoas, pectineus, and adductor longus muscles principally form the floor of the triangular space, which is bisected by the femoral vessels, from the base to the apex. The femoral artery and vein are inclosed together in a strong fibrous sheath, made partly by a process of the *fascia lata* of the thigh; but each vessel has also its thinner sheath.

Fig. 70.



In the middle third of the thigh the femoral is more deepy seated. Over it is the sartorius muscle, inside of it the adductor longus and adductor magnus, and outside of it the vastus internus muscle.

The femoral vein here lies to the outside of it; and just beyond that is the long or internal saphenous nerve.

The branches of the *femoral* artery are the *superficial epigastric*, *superficial circumflex iliac*, *superficial external pudic*, *deep external pudic*, *profunda femoris*, *muscular*, and *anastomotica magna.*

The *superficial epigastric* ascends through the saphenous opening of the fascia lata, to pass over the external oblique muscle of the abdomen, in the superficial fascia, to the umbili-

Arteries of the Pelvis and Thigh.—1. Inferior extremity of abdominal aorta 2. Right primitive iliac. 3. Right external iliac. 4. Epigastric artery. 5. Circumflex ilii. 6. Internal iliac. 7 Ileo lumbar. 8. Gluteal. 9 Obturator. 10. Lateral sacral. 11. Vesical arteries cut off. 12. Middle hemorrhoidal. 13. Internal pudic. 14. Ischiatic. 15. Origin of femoral artery. 16. Point where it passes through the adductor muscles. 17. Profunda major. 18. Internal circumflex.

cus. Its subdivisions anastomose with those of the deep epigastric and internal mammary arteries.

The *profunda femoris*, nearly as large as the femoral, arises from its outer and back part, an inch or two below Poupart's ligament. Passing to the inner side of the femur, it goes through the adductor magnus muscle to the back of the thigh. Its main branches are the *external* and *internal circumflex*, and the three *perforating* arteries.

The *external circumflex* goes to the muscles on the front of the thigh. The *internal circumflex* winds round the femur to supply a number of muscles. The three *perforating* arteries go through the tendons of the adductor brevis and adductor magnus muscles.

The *muscular* branches of the femoral, from two to seven, go principally to the sartorius and vastus internus.

The *anastomotica magna* is the last to leave the femoral before it becomes the popliteal. It divides into two branches; the deeper of which has some ramifications reaching to the knee-joint.

Popliteal Artery.

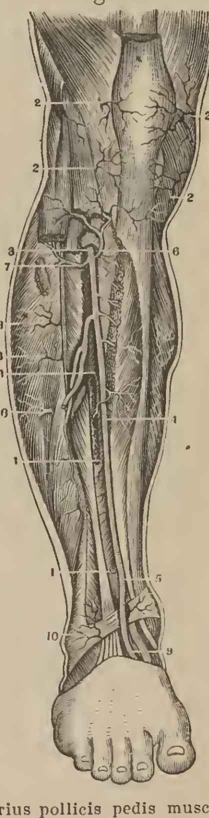
From the opening of the adductor magnus muscle, the popliteal goes obliquely outwards and downwards, behind the knee, to divide, at the lower edge of the popliteus muscle, into the *anterior* and *posterior tibial* arteries. Over the popliteal, at first, lies the semi-membranosus muscle; lower, it is covered by the gastrocnemius, soleus, and plantaris muscles, the popliteal vein, and internal popliteal nerve.

Branches of the popliteal are the *superior muscular*, *inferior muscular or sural*, *cutaneous*, *superior external and internal articular*, *azygos articular*, *inferior external*, *and internal articular*.

Anterior Tibial Artery.

This vessel passes from the bifurcation of the popliteal, between the heads of the tibialis posticus muscle, and between the tibia and fibula, to the deep part of the front of the leg. It then goes down on the interosseous ligament and tibia, becoming more superficial in front of the

Fig. 71.



ANTERIOR TIBIAL ARTERY.—1, 1. Extensor proprius pollicis pedis muscle and tendon. 2, 2. Articular arteries. 3. Anterior tibial artery. 4, 5. The same artery. 6. Recurrent branch. 7. Branch to muscles. 8, 8. Other muscular branches. 9. Pedal artery, or continuation of the anterior tibial on the foot. 10. External malleolar artery.

ankle, as the *dorsalis pedis.* It has two *venæ comites*, one on each side.

Its branches are the *recurrent tibial*, *muscular*, *internal malleolar*, and *external malleolar.*

Its terminal continuation, the *dorsalis pedis* artery, runs along the tibial side of the foot to the first inter-metacarpal space; there it divides into the *dorsalis hallucis* and the *communicating artery.* Other branches of it are the *tarsal*, *metatarsal*, and *interosseal* vessels.

The *dorsalis hallucis* divides into two branches, one for the inner side of the great toe, and the other for the adjoining sides of the great and second toes.

The *communicating artery* dips down into the sole of the foot, to anastomose with the external plantar artery, forming the *plantar arch*, and giving off two digital branches, for the great and second toes.

Posterior Tibial.

From the popliteus muscle this artery goes along the tibial side of the leg, behind the tibia, to the fossa between the inner malleolus and the heel; there to divide into the *internal* and *external plantar.* Covered above by the gastrocnemius and soleus muscles, in its lower third it is covered only by the skin and fascia, on the inner side of the tendo Achillis. It has two companion veins. The posterior tibial nerve lies above, on the inner side of the artery; soon it crosses it, and lies chiefly on its outer side.

The branches of the *posterior tibial* artery are the *peroneal*, *muscular*, *nutritious*, *communicating*, and *internal calcanean.*

Peroneal Artery.

This vessel leaves the posterior tibial about an inch below the popliteus muscle. It goes obliquely outwards to the fibula, and descends along its inner border to the lower third of the leg; there it sends off the *anterior peroneal*, which pierces the interosseous ligament to pass down the front of the leg to the tarsus. The other branches of the peroneal are muscular.

Plantar Arteries.

These are the terminal branches of the posterior tibial. The *external* plantar is the larger. It goes, from the space between the inner ankle and the heel, outwards and forwards to the base of the last metatarsal; then it turns inwards to the space between the first and second metatarsal bones, to complete the plantar arch by joining the communicating branch of the dorsalis pedis.

The *internal plantar* passes forwards along the inner side of the foot, and inner border of the great toe; anastomosing with its digital branches.

From the *plantar arch* the largest branches of many are the three *posterior perforating*, and the four *digital* vessels. The latter, at the bifurcation of the toes, send off the *anterior perforating* branches, to join the *interosseous* branches of the *metatarsal* artery.

Both sides of the three outer toes, and the outer side of the

second toe, are supplied by branches from the plantar arch ; both sides of the great toe, and the inner side of the second, by the *dorsalis pedis* artery.

VEINS.

The capacity of the venous system is nearly three times as great as that of the arterial ; the veins being both larger and more numerous than the arteries. The veins communicate very freely with each other. Each vein has *three* coats ; *internal*, *middle*, and *external*. The *first*, like that of the arteries, is composed of connective tissue and epithelium, resembling serous tissue. The *middle* coat contains less muscular and elastic tissue than that of the arteries. The *muscular* tissue is greatest in amount in the *larger* veins, near the heart. The *external* coat is much like that of the arteries, but thinner, and contains longitudinal muscular fibres.

Most veins have *valves*, at intervals along their course, formed of projections or folds of the middle and inner coats, semilunar in shape. They open only towards the heart. Valves are most numerous in the veins of the lower limbs. There are *no* valves in the *smallest* veins, nor in the *venæ cavæ*, *hepatic* vein, *portal* vein, *pulmonary*, *cerebral*, *spinal*, *renal*, *uterine*, and *ovarian* veins ; nor in the *umbilical* vein of the fœtus. Veins have nutritious vessels, or *vasa vasorum*, like the arteries.

Exterior Veins of the Head.

These are the *facial*, *temporal*, *internal maxillary*, *temporo-maxillary*, *posterior auricular*, and *occipital* veins.

The *facial* vein runs from the inner angle of the eye obliquely across the face to the front edge of the masseter muscle. Its origin is in the *frontal* vein, which descends near the middle of the forehead ; those of the two sides, at first parallel, uniting at the root of the nose by the transverse trunk called the *nasal arch*.

The *facial* vein, lying outside of the facial artery, crosses the jaw, and in the neck joins with a branch from the temporo-maxillary vein to empty into the internal jugular. The facial receives, as branches, some from the pterygoid plexus, and the inferior palpebral, labial, buccal, masseteric, submental, inferior palatine, submaxillary, and ranine veins.

The *temporal* vein begins on the side of the head in a minute plexus, the trunk from which, above the zygoma, is joined by the *middle temporal* vein. The temporal vein goes down between the ear and the condyle of the jaw, enters the parotid gland, and joins the *internal maxillary* vein to form the *temporo-maxillary*. The branches of the temporal are small, except the *transverse facial*, from the side of the face.

The *internal maxillary* is a considerable vein, whose branches correspond with those of the internal maxillary artery ; being the *middle meningeal*, *deep temporal*, *pterygoid*, *masseteric*, *buccal*, *palatine*, and *inferior dental*.

The *temporo-maxillary* vein, formed by the union of the last two,

11

divides in the parotid gland into two branches, one of which joins the *facial*, and the other the *external jugular.*

The *posterior auricular*, beginning on the side of the head, by a plexus, descends behind the ear to empty into the *temporo-maxillary* vein.

The *occipital* vein commences in a plexus at the back of the head, and follows the course of the occipital artery, beneath the muscles of the neck, to end, generally, in the *internal jugular;* sometimes in the *external jugular.* By the *mastoid* vein, it communicates with the *lateral sinus* of the dura mater.

Veins of the Neck.

These are the *external jugular*, *posterior external jugular*, *anterior jugular*, *internal jugular*, and *vertebral.*

The *external jugular* vein is a continuation of the temporo-maxillary and posterior auricular, from the parotid gland down the neck to the middle of the clavicle. There it penetrates the deep fascia to join the subclavian vein. Sometimes it is double.

The *posterior external jugular* descends at the back of the neck to empty into the external jugular.

The *anterior jugular* goes down on the inner side of the anterior edge of the sterno-cleido-mastoid muscle, to join the subclavian. It varies in size.

The *internal jugular* vein is formed in the jugular foramen at the base of the skull, by the junction of the lateral and inferior petrosal sinuses. It passes down the neck, outside of the carotid artery, to join the subclavian at the root of the neck, thus forming the *vena innominata.* Its branches are the *facial*, *lingual*, *pharyngeal*, *superior* and *middle thyroid*, and *occipital* veins.

The *vertebral* vein, beginning in the occipital region, goes through the foramina of the transverse processes of the upper six cervical vertebræ; then emptying into the vena innominata.

Veins of the Interior of the Skull.

The *diploë* of the cranium has a number of tortuous canals, containing large veins with thin walls, enlarged at intervals into pouches. They communicate with the sinuses of the dura mater, and with the exterior veins of the head.

The *cerebral* vein has thin coats, without muscular tissue, and without valves. They are *superficial* and *deep;* eight or ten in number. They and the *cerebellar* veins empty into the sinuses of the dura mater.

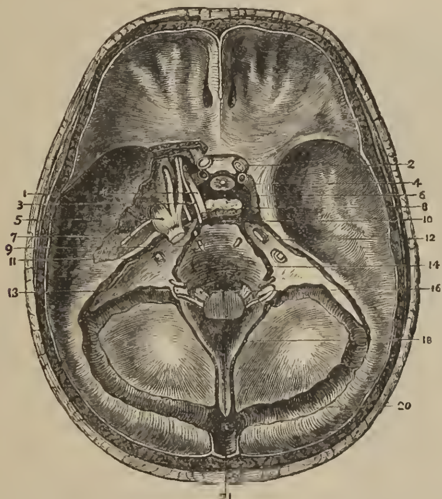
The *sinuses of the dura mater* are channels for venous blood, having for their outer coat the dura mater itself. They are twelve; five at the upper and back part of the skull, and seven at the base of the skull.

The first named are the *superior* and *inferior longitudinal*, the *straight*, *lateral*, and *occipital* sinuses.

The *superior longitudinal* sinus runs backwards from the crista galli of the ethmoid bone, making a groove in the frontal, the junction of the parietal, and the occipital bones. At the crucial edge of the last, it divides into the *two lateral* sinuses. The *glands*

of Pacchioni are small white bodies projecting from the inner surface of this sinus. The junction of the three sinuses just named is the *torcular Herophili.*

Fig. 72.



THE SINUSES OF THE SKULL AND CRANIAL NERVES ; THE CAVERNOUS SINUS DISSECTED ON THE LEFT SIDE.—1. 3d nerve. 2. Optic nerve. 3. 4th nerve. 4. Internal carotid artery. 5. Gasserian ganglion of 5th nerve with its three divisions. 6. Circular sinus. 7. Superficial petrosal nerve. 8. Cavernous sinus. 9. 6th nerve. 10. Transverse or basilar sinus. 11. 7th pair. 12. Superior petrosal sinus. 13. 8th pair. 14. Inferior petrosal sinus. 16. 9th nerve of left side. 18. Occipital sinus. 20. Lateral sinus. 21. Torcular Herophili.

The *inferior longitudinal* sinus or vein occupies the back and free part of that fold of the dura mater called *falx cerebri.* It ends in the *straight* sinus.

The *straight* sinus is at the junction of the *falx* with the *tentorium.* It joins the other sinuses at the *torcular Herophili.*

The *lateral* are two large sinuses, passing from the *torcular* first outwards, and then coming downwards and inwards to empty into the jugular vein at the jugular foramen. The right one is larger than the left.

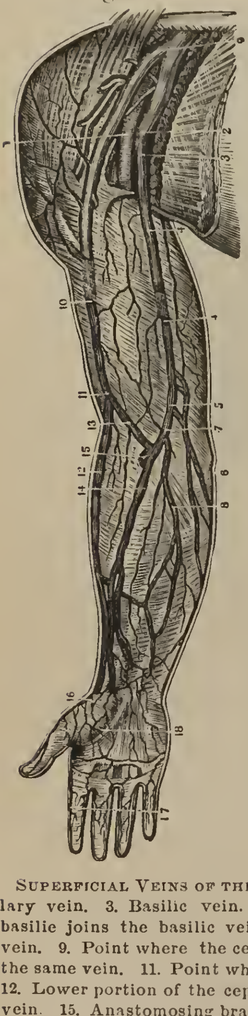
The *occipital* sinuses are the smallest. They are in the attached margin of the *falx cerebelli*, and end at the *torcular Herophili.*

The sinuses at the base of the cranium are the *cavernous*, *circular*, *superior* and *inferior petrosal*, and *transverse.* The *circular* and *transverse* communicate, near the middle of the base of the skull, between the sinuses of the two sides. The *cavernous* are short and longitudinal ; with a reticulated structure.

Veins of the Arm and Hand.

These are *superficial* and *deep*. The first begin chiefly on the back of the head. The last are the *venæ comites* of the arteries.

Fig. 73.



Superficial are the *anterior ulnar*, *posterior ulnar*, *basilic*, *radial*, *cephalic*, *median*, *median basilic*, and *median cephalic* veins.

The *anterior ulnar* and *posterior ulnar*, named from their situation, join at the bend of the elbow to form the *basilic* vein. This runs up, receiving the *median basilic* in an oblique direction, and pierces the deep fascia to join one of the *venæ comites*, or the axillary vein.

The *radial* runs up on the outside of the forearm from the back of the thumb and index finger. Receiving obliquely the *median cephalic* at the bend of the elbow, it becomes the *cephalic* vein. This runs outside of the biceps muscle to the upper third of the arm; then passes between the pectoralis major and deltoid muscles, to end in the axillary vein below the clavicle.

The *median* vein runs up from the palm of the hand, near the middle of the forearm, to divide at the bend of the elbow into the *median cephalic* and the *median basilic;* of which, as said above, the one joins the cephalic and the other the basilic vein. Branches of the external cutaneous nerve pass behind the median cephalic, and filaments of the same nerve pass both behind and in front of the median basilic vein.

Veins of the Thorax.

The *axillary* vein, the continuation of the basilic, increasing in size in the axilla by the supply of the *venæ comites* of the arteries of the arm, becomes the *subclavian* vein, under the clavicle at the margin of the first rib.

SUPERFICIAL VEINS OF THE UPPER EXTREMITY.—1. Axillary artery. 2. Axillary vein. 3. Basilic vein. 4, 4. Basilic vein. 5. Point where the median basilic joins the basilic vein. 6. Posterior basilic vein. 8. Anterior basilic vein. 9. Point where the cephalic enters the axillary vein. 10. A portion of the same vein. 11. Point where the median cephalic enters the cephalic vein. 12. Lower portion of the cephalic vein. 13 Median cephalic vein. 14. Median vein. 15. Anastomosing branch. 16. Cephalica-pollicis vein. 17. Subcutaneous veins of the fingers. 18. Subcutaneous palmar veins.

The *subclavian* vein, at the inner end of the sterno-clavicular junction, unites with the internal jugular to form the *vena innominata*. At their angle enters the thoracic duct. The subclavian receives as branches the external, anterior, and internal jugular veins. It is separated from the subclavian artery by the scalenus anticus muscle.

The *right vena innominata* is about an inch and a half long. It goes almost directly downwards, to join the *left* vena innominata to form the *descending vena cava*, just below the cartilage of the first rib. It is external to, and nearer the surface than the arteria innominata. At the angle of junction of this vein and the subclavian, enters the vertebral vein. Lower down it receives the internal mammary, inferior thyroid, and superior intercostal veins.

The *left vena innominata* is longer and larger than the right. It passes obliquely across the upper anterior part of the cavity of the chest, to join the right in forming the *vena cava*.

The *vena cava descendens* is a large trunk, two and a half to three inches long, vertical in its direction, entering the pericardium an inch and a half above the heart, and then emptying into the upper part of the right auricle.

The *right* and *left azygos* veins, of which the *right* is the larger, connect the descending and ascending *venæ cavæ*. The *right* azygos receives nine or ten lower *intercostal* veins, the right *bronchial*, and other veins. The *left lower azygos* receives four or five lower intercostal and a few other small veins. The *left upper* azygos receives the upper intercostal veins except the superior intercostal.

The *left bronchial* vein empties into the *left superior intercostal*. The bronchial veins carry back the blood from the tissue of the lungs.

Spinal Veins.

These form venous *plexuses*, as follows: *dorso-spinal* veins, outside of the spinal column; *meningo-rachidian* veins, within the canal, outside of the membranes of the cord; *venæ basis vertebrarum*, of the bodies of the vertebræ; *medullo-spinal*, or the veins of the spinal cord.

Those of the *first* set, in the intervals between the vertebræ, terminate in the neck, in the vertebral veins; in the chest, in the intercostals; in the lumbar region in the lumbar and sacral veins.

Of the second set, there are two plexuses, the *anterior* and the *posterior longitudinal* spinal veins. The terminating connections are like those of the first set.

The veins of the *third* set join the transverse trunks which convert the anterior longitudinal spinal veins of the two sides. Those of the *fourth* set unite with the other veins of the spinal canal.

Veins of the Lower Extremity.

These are *superficial* and *deep;* the latter being the *venæ comites* of the arteries.

The *superficial* veins of the lower extremity are the *long internal saphenous*, and the *short external saphenous* vein.

The *internal saphenous* vein ascends, from a plexus of small veins on the back and inner side of the foot, in front of the inner malleolus, up the inside of the leg, behind the inner margin of the tibia. Going backwards gradually, at the knee it is behind the internal condyle of the femur; thence it passes up the inside of the thigh to the *saphenous opening*, where it penetrates the fascia lata and ends in the *femoral* vein, an inch and a half below Poupart's ligament. At the saphenous opening it receives the *superficial epigastric*, *superficial circumflex iliac*, and *external pudic* veins. Its other branches are cutaneous. The internal saphenous nerve accompanies it.

The *external saphenous* vein ascends, from a plexus on the back and *outer* side of the foot, behind the outer malleolus, outside of the tendo Achillis, and then across it, to the middle of the back of the leg. Passing upwards, it penetrates the fascia in the lower part of the popliteal region, and ends in the *popliteal* vein, between the heads of the gastrocnemius muscle. The external saphenous nerve accompanies it.

Fig. 74.

SUPERFICIAL VEINS OF THE LEGS.—1. Saphena major. 2. Collateral branch. 3. Anastomosis of veins. 4. Internal saphena 5. Origin of the saphena vein. 6 Anastomosing branch. 7. Branches on the back of the leg. 8. The great internal vein of the foot. 9. Arch of veins on the metatarsal bones. 10. Branch from the heel. 11. Branches on the sole of the foot.

The arteries of the leg are attended by *venæ comites* or deep veins. These are supplied, particularly, by the *external* and *internal plantar*, and the *peroneal* veins.

The *popliteal* vein is formed by the union of the anterior and posterior tibial *venæ comites*. Passing up through the popliteal space to the opening in the tendon of the adductor magnus muscle, it becomes the *femoral* vein. *Below*, it is on the *inner* side of the artery; then it lies between it and the integument; above, it is *outside* of it.

The *femoral* vein runs with the femoral artery. *Below*, it is *outside* of it; then, *behind* it; near Poupart's ligament, it is on the *inner* side of it. Its principal branch is the *profunda femoris*.

The *external iliac* vein is the continuation of the femoral, above the crural arch. Going along the margin of the pelvis it unites, near the sacro-iliac symphysis, with the *internal iliac* to form the *common iliac* vein.

The *internal iliac* vein is supplied by the *venæ comites* of the branches of the internal iliac artery. Besides other branches, important ones are those of the *hemorrhoidal* and *vesico-prostatic*, and, in the female, *uterine* and *vaginal* plexuses. The *hemorrhoidal* plexus surrounds the lower end of the rectum.

The *vena dorsalis penis* is a large vein which returns the blood of the penis, along its back, to the prostatic plexus.

The two *common iliac* veins unite, opposite the space between the fourth and fifth lumbar vertebræ, to form the *ascending vena cava*. The *right* common iliac is shorter and more nearly vertical in its course than the *left*.

The *inferior or ascending vena cava* lies upon the spinal column to the *right* of the aorta. Passing through a groove in the posterior border of the liver, it penetrates the tendon of the diaphragm, and enters the pericardium, covered by its serous lining, to empty into the lower and posterior part of the right auricle.

Branches of the ascending vena cava are the *lumbar*, *right spermatic*, *renal*, *supra-renal*, *phrenic*, and *hepatic* veins.

The *lumbar* veins are three or four in number. The *spermatic* veins come, along the spermatic cords, from the testes. The *left* spermatic empties into the *renal*. The *ovarian* veins in the female correspond with them.

The *renal* veins are large ; the *left* is longer than the *right* renal.

The *hepatic* veins, three in number, one from the right lobe, one from the left, and one from the middle of the liver, bring the blood from its substance ; supplied by the portal vein and hepatic artery.

Portal System.

This is composed of *four* large veins, collecting blood from the digestive organs, and joining to make the *vena portæ*, which enters and ramifies within the liver. The four veins are the *superior* and *inferior mesenteric*, the *splenic*, and the *gastric* veins.

The *superior mesenteric* is supplied from the small intestines, cæcum, and transverse colon.

The *inferior mesenteric* receives its branches from the descending colon, sigmoid flexure, and rectum. It empties into the *splenic* vein. By anastomoses of its hemorrhoidal branches with the branches of the internal iliac, the portal system, and the general venous circulation are connected.

The *splenic* vein receives the blood of five or six venous trunks from the spleen, and, also, the *vasa brevia* from the stomach, the *left gastro-epiploic* vein, *pancreatic*, *pancreatico-duodenal*, and *inferior mesenteric* veins.

.The *gastric* vein is small, accompanying the gastric artery along the upper curvature of the stomach.

The *portal* vein, from the junction of the *splenic* and *superior mesenteric*, in front of the *vena cava*, behind the pancreas, goes up to the transverse fissure of the liver. Enlarged there into a *sinus*, it divides into two trunks, which ramify through the substance of

the liver, communicating with the branches of the hepatic artery. The portal vein is about four inches in length.

Pulmonary Veins.

These are four, two for each lung, returning blood from the capillaries around the air cells. They have no valves, are but little larger than the pulmonary arterial trunks, and carry *arterial* blood. There is a venous trunk for each pulmonary *lobe;* making three for the right lung and two for the left. The pulmonary veins empty into the left auricle of the heart.

Cardiac Veins.

The blood from the heart's substance is returned by the *great anterior* and *posterior cardiac* veins, and the *venæ Thebesii.* The *great cardiac* and *posterior cardiac* make the *coronary sinus*, which lies in the posterior part of the left auriculo-ventricular groove, and empties into the right auricle. The *anterior cardiac* and the *venæ Thebesii* open into the right auricle directly. The coronary sinus receives also a small *oblique* vein from the left auricle, the remainder of a trunk of the fœtal circulation.

Lymphatics.

These are delicate vessels with three coats, almost transparent, constricted at intervals so as to have a *beaded* appearance, passing

Fig. 75.

LYMPHATICS OF THE JEJUNUM AND MESENTERY, INJECTED: THE ARTERIES ARE ALSO INJECTED.—1. Section of the jejunum. 2. Section of the mesentery. 3. Branch of the superior mesenteric artery. 4. Branch of the superior mesenteric vein. 5. Mesenteric glands receiving the lymphatics of this intestine.

through numerous *lymphatic glands*, to combine and empty at last into the *left* or *greater*, or into the *right* or *lesser thoracic duct.* All organs have lymphatics *except* the brain, spinal cord, eyeball, cartilages, tendons, nails, hair, cuticle, umbilical cord, placenta, and membranes of the ovum.

Lymphatic *glands* are most numerous in the neck, axilla, groin, and abdomen.

The lymphatic vessels of the *small intestine* are called *lacteals*, from the milky character of the chyle which they absorb. The glands which they pass through are the *mesenteric* glands.

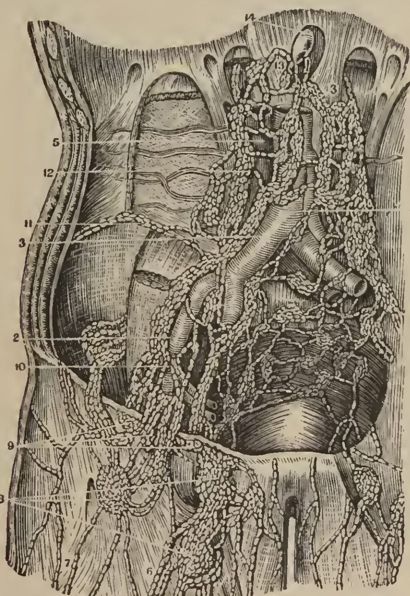
Left Thoracic Duct.

This principal trunk receives most of the lymphatics and all the lacteals. It extends from the second lumbar vertebra to near the neck. Its beginning is the *receptaculum chyli;* which lies behind and to the right of the aorta. The thoracic duct passes up through the aortic foramen in the diaphragm, goes up to the left behind the arch of the aorta, near the œsophagus; then near the seventh cervical vertebra it curves downwards, to end at the angle of union of the left internal jugular and the subclavian veins. It has numerous valves. Its diameter is not uniform, but is about that of a small quill.

Right Thoracic Duct.

This is but an inch or so in length. It receives lymphatics from

Fig. 76.



Femoral Iliac and Aortic Lymphatic Vessels and Glands.—1. Saphena magna vein. 2. External iliac artery and vein. 3. Primitive iliac artery and vein 4. Aorta. 5. Ascending vena cava. 6, 7. Lymphatics. 8. Lower set of inguinal lymphatic glands. 9. Superior set of inguinal lymphatic glands. 10. Chain of lymphatics. 11. Lymphatics which accompany the circumflex iliac vessels. 12. Lumbar and aortic lymphatics. 13. Origin of the thoracic duct. 14. Thoracic duct at its commencement.

the right side of the head, neck, chest, right upper extremity, right lung, right side of the heart, and upper surface of the liver. It ends in the angle of junction between the right internal jugular and right subclavian veins; having two valves at its termination.

CHAPTER VII.

THE SKIN.

The skin consists of two layers; the *cutis vera*, *derma*, *chorion*, or true skin, and the *cuticle*, *epidermis*, or scarf-skin.

The *cutis vera* may be described as composed of the deep layer or *corium*, formed of fibro-connective (white fibrous and yellow elastic) tissue, and the *papillary* layer.

The latter consists of numerous small conical eminences or *papillæ*, $\frac{1}{100}$th of an inch in length, and $\frac{1}{250}$th of an inch in diameter at the base. On the palm of the hand and sole of the foot they are larger, and are in close parallel lines or ridges. Each *papilla* contains one or more capillary loops and one or more nerve-fibres, whose mode of termination is not yet ascertained.

On the lips and fingers, the nervous filaments of the papillæ have attached to them oval bodies of minute size, the *Pacinian corpuscles*.

The *epidermis* is an insensitive epithelial tissue of various thickness; composed of layers of almost *flattened cells*, most rounded and columnar in the deepest layers.

The color of the negro and other dark races, and in less degree that of all persons except *albinos*, depends upon the presence of pigment in the deeper layer (*rete mucosum*) of the epidermis.

The *lymphatics* of the skin are especially abundant around the nipple and in the scrotum.

The Nails.

These are horny structures growing from the skin. The nail is planted in a groove or doubling of skin (the *matrix*), by its root; it has also a body and a free edge. The *lunula* is the white part of the nail just in advance of the root. The nail grows constantly forwards by the formation of new cells from its root and the under surface of its body.

The Hair.

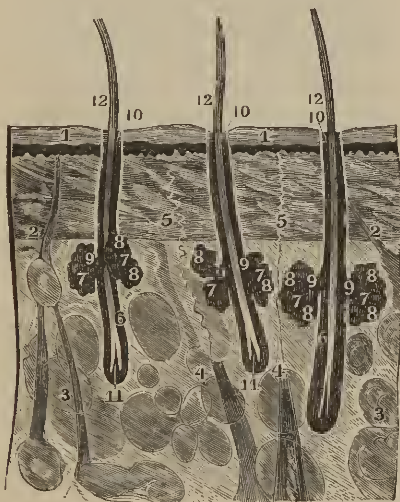
Hairs also are growths from and modifications of epidermic tissue. Each hair is composed of a *root* and a pointed *shaft*. The root is lodged in a depression of the skin, the *hair-follicle*. The *shaft* of the hair consists of a central, deep-colored and opaque *medulla*, a fibrous surrounding to this, and an outer part or *cortex*. Around the roots of the hairs a few unstriped muscular fibres are found in the skin.

Glands of the Skin.

These are the *sebaceous* and the *sudoriferous* glands.

The *sebaceous* glands abound most in connection with the hair-follicles, into which their ducts open. They are largest on the face, especially about the nose. Those of the eyelids are called *Meibomian* glands.

Fig. 77.



SEBACEOUS GLANDS AND FOLLICLES OF HAIRS IN THE SKIN OF THE AXILLA.—1. Epidermis. 2. Cutis vera. 3. Adipose tissue. 4, 4. Two perspiratory follicles. 5, 5. Their spiral canals. 6, 6. Follicles of hairs. 7, 7. Sebaceous glands. 10, 10. The orifices of the follicles of the hairs. 11, 11. Their roots. 12, 12. The hairs as seen under the microscope.

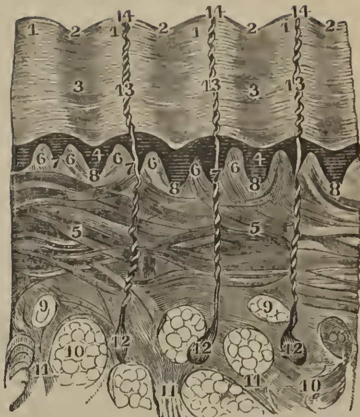
The *sudoriferous* or sweat glands are distributed over the skin in great numbers. On the palm of the hand there are estimated to be 2800 of them on a square inch.

Each gland consists of a convoluted tube, passing spirally through the skin from the deepest part of the corium or subcutaneous areolar tissue. It opens obliquely on the surface by a slightly enlarged valve-like orifice.

Connective Tissue.

Cellular, *areolar*, or *connective* tissue is the general *packing* or interstitial material of all parts of the body except certain organs of peculiar structure. It abounds under the skin, and between the fibres and layers of muscles. It is white and silky in appear-

Fig. 78.



SUDORIFEROUS ORGANS OF THE SOLE OF THE FOOT.—12. The sudoriferous follicles. 13. The spiral or sudoriferous canals. 14. The infundibular-shaped pores or orifices of these canals.

ance, and is in nature allied to fibrous tissue, but more delicate in its subdivisions. Virchow asserts it to be a sort of generative tissue for other fabrics of the body, and to contain or consist of a number of *corpuscles* with pointed or linear processes by which they are joined together. Though adopted by many, this statement is not yet considered by all anatomists to be proved.

The areolar or connective tissue is moistened by a serosity or transudation from the bloodvessels; the excessive accumulation of this constitutes œdema or anasarca.

Fat.

The adipose tissue of the body is formed by the retention of an almost liquid oleaginous material (olein, palmitin, and a little stearin) in cells or spaces like those of the areolar tissue. It abounds under the skin, especially over the abdomen. More of it exists in general distribution under the skin of the female than under that of the male. Fat is also placed in some of the cavities of the body; as in the orbit of the eye, around the heart, and around the kidneys. The marrow of the bones is in part a similar substance; though more vascular, and somewhat peculiar in composition.

CHAPTER VIII.

MUSCLES.

Structure.—There are two sorts of muscular tissue; that of the quickly acting and mostly voluntary muscles, and that of the involuntary muscles of the organs of nutritive functions, whose action is slower and alternating, or *peristaltic.*

The *muscles of voluntary or animal life* are made up of bundles of red fibres, and these of *primitive fasciculi*, each of which is inclosed in a *sarcolemma* or sheath. The primitive fasciculus is formed by the binding together of filaments or *primitive fibrils.* Each of these is a flattened cylinder $\frac{1}{18000}$ of an inch in thickness, with wavy parallel lines around it (seen by aid of the microscope) transversely. It is hence called *striated* or *striped* muscular tissue. Most anatomists consider each primitive fibril to consist of a row of connected, almost rectangular, contractile *cells* or *sarcous elements;* which widen and shorten in the contraction of the muscle.

The *unstriped muscles of organic life* are composed of pale flattened bands, or bundles of spindle-shaped fibres, $\frac{1}{4700}$ to $\frac{1}{3100}$ of an inch in diameter. Every fibre has an elongated *nucleus*, visible by aid of the microscope.

The *striped* muscle exists in all the voluntary muscles; in those also of the larynx, pharynx, upper half of the œsophagus, heart, and largest of the veins.

Unstriped muscular tissue is found throughout the alimentary canal, in the trachea and bronchial tubes, gall-bladder, bile-duct and other gland-ducts, calyces and pelvis of the kidney, uterus, bladder and urethra, iris, ciliary muscle, skin, all arteries, lymphatics, and veins. In the male, it is also present in the scrotum, epididymis, vas deferens, vesiculæ seminales, and prostate gland. In the female, in the uterus, Fallopian tubes, broad ligaments, and vagina. Also, in the *corpora cavernosa* of the penis in the male, and of the clitoris in the female.

The voluntary muscles vary much in form. Each is enveloped in its *sheath*, and terminates at one or both ends, or, as in the diaphragm, at its centre, in a white fibrous *tendon.* The tendon may be of any shape, but is most generally a rounded cord. All muscles are well supplied with nerves and bloodvessels.

Aponeuroses are fibrous membranes, pearly white, connected with muscles and also with bones, cartilages, ligaments, etc.

Fasciæ are aponeurotic layers of various thickness, inclosing and protecting, as well as retaining in their places, the organs in all parts of the body. They are divisible chiefly into the *superficial* and the *deep* fasciæ.

The *superficial fascia* extends under the integument over the whole body.

The deep fascia is more immediately connected with the muscles; giving a sheath to each of them, and also sheaths to the nerves and bloodvessels.

MUSCLES OF THE HEAD AND FACE.

Occipito-frontalis.—Origin, from the occiput, by two flat bellies; *course*, over the cranium; on the frontal bone are formed two other flat bellies, one on each side; *insertion*, into the nasal bones, and os frontis near them, and into the upper edge of the *corrugator supercilii* and *orbicularis oculi* muscles. *Action*, to raise or depress the eyebrows and skin of the forehead; sometimes that of the occiput.

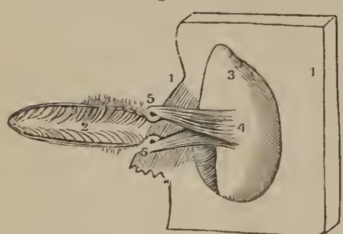
Attollens aurem, Attrahens aurem, Retrahens aurem.—Three small *rudimentary* or imperfectly developed muscles, seldom capable of use in man. They are immediately under the skin; the *attollens* above the ear, the *attrahens* above and in front of it, the *retrahens* behind and below it. The first two originate in the occipito-frontalis muscle; the third, in the mastoid process of the temporal bone. The first, in action, would raise the ear; the second would draw it forward; the third would draw it backward.

The muscles of the *tympanum* will be described with the organ of hearing.

Corrugator supercilii.—Origin, internal angular process of the os frontis. *Course*, obliquely upwards and outwards for a short distance. *Insertion*, the junction of the *occipito-frontalis* and *orbicularis oculi* muscles. *Action*, *frowning*.

Orbicularis oculi.—Origin, upper end of nasal process of superior maxillary bone, internal angular process of frontal bone, and upper margin of palpebral ligament. *Course*, entirely around the eye or edge of the orbit. *Action*, to close the eyelids.

Fig. 79.



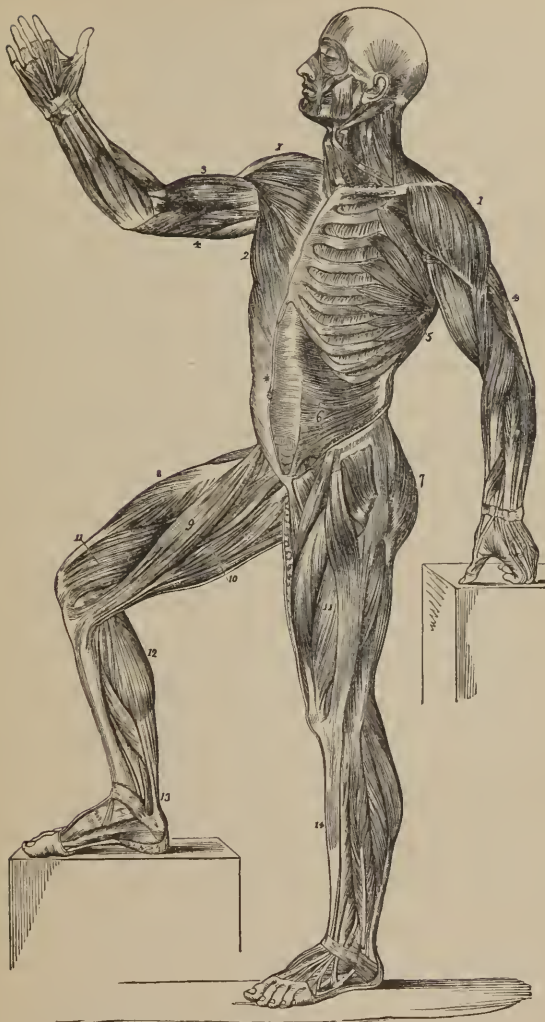
A VIEW OF THE TENSOR TARSI MUSCLE.—1, 1. Bony margins of the orbit. 2. Opening between the eyelids. 3. Internal face of the orbit. 4. Origin of the tensor tarsi. 5, 5. Insertion into the neighborhood of the puncta lachrymalia.

Levator palpebræ superioris.—Origin, upper and back part of the orbit of the eye. *Course*, forward over the eyeball, widening as it goes. *Insertion*, the upper eyelid. *Action*, to raise the lid and open the eye.

Tensor tarsi, or *Horner's muscle.—Origin*, os unguis. *Course*, forwards a quarter of an inch, when it *bifurcates*. *Insertions*, one branch into each lachrymal duct. *Action*, to dilate the lachrymal ducts, and keep the lids close upon the eyeball.

Muscles of the eyeball—Rectus superior.—Origin, upper part of optic foramen in the rear of the orbit, and inner margin of sphenoidal fissure. *Course*, forward. *Insertion*, upper part of the eyeball, a little behind the cornea. *Action*, to raise the eye.

Fig. 80.



MUSCLES—FRONT VIEW.—On the right half, the superficial muscles. Left half, deep-seated muscles.

Rectus inferior.—*Origin*, from the lower margin of optic foramen; by the *ligament of Zinn*, a tendinous beginning for it and the internal and external recti muscles. *Course*, forwards. *Insertion*,

lower part of eyeball behind the cornea. *Action*, to depress the eye.

Rectus internus.—Origin, ligament of Zinn, and sheath of the optic nerve (with which the other recti muscles also have some connection). *Course*, forwards. *Insertion*, eyeball behind the cornea. *Action*, to draw the eye inwards towards the nose.

Rectus externus.—Origin, by two heads, one from the common ligament or tendon of Zinn, the other from the margin of the optic foramen. Between these two heads pass the third and sixth nerves and the nasal nerve. *Course*, forwards. *Action*, to draw the eye outwards.

Obliquus superior or *Trochlearis.—Origin*, margin of optic foramen and sheath of nerve. *Course*, forwards to the *trochlea* or pulley-like process near the internal angle of the os frontis through which its round tendon passes, thence turning downwards and backwards. *Insertion*, sclerotic coat near the entrance of the optic nerve. *Action*, to roll the eye downwards and outwards. It is sometimes called *musculus patheticus*.

Obliquus inferior.—Origin, inner margin of upper maxillary bone. *Course*, beneath the *rectus inferior*, outwards and somewhat backwards. *Insertion*, outer and posterior part of eyeball. *Action*, to roll the eye obliquely inwards and downwards.

Pyramidalis nasi.—Origin, lower margin of occipito-frontalis. *Course*, downwards. *Insertion*, upper edge of *compressor naris* muscle. *Action*, to draw down the skin of the forehead, or draw up that of the nose.

Compressor naris.—Origin, root of ala nasi on one side. *Course*, across the dorsum of the nose. *Insertion*, into the corresponding muscle of the other side. *Action*, to compress the nostril.

Levator labii superioris alæque nasi.—Origin, by two slips, from nasal and orbitar processes of upper maxillary bone. *Course*, downwards. *Insertions*, one slip into the upper lip, the other into the ala or wing of the nose. *Action*, to raise the upper lip and dilate the nostril.

Depressor labii superioris alæque nasi.—Origin, alveoli of front teeth. *Course*, upwards. *Insertion*, upper lip and ala nasi. *Action*, to draw down the upper lip and the nose.

Levator anguli oris.—Origin, upper maxillary bone under the orbit of the eye. *Course*, downwards and inwards. *Insertion*, angle of the mouth. *Action*, to raise the corner of the mouth.

Zygomaticus major, and *Zygomaticus minor.—Origin*, malar part of zygoma. *Course*, downwards and forwards. *Insertion*, angle of mouth and upper lip. *Action*, to raise and draw out the corner of the mouth.

Orbicularis oris.—A *circular* muscle, surrounding the mouth, in the lips. *Action*, to close the mouth.

Depressor anguli oris.—Origin, base of lower jaw at the side of the chin. *Course*, obliquely, some fibres vertically, upward to an apex. *Insertion*, corner of the mouth. *Action*, to draw down the corner of the mouth.

Depressor labii inferioris.—Origin, base of lower jaw at the side of the chin. *Course*, upwards and inwards. *Insertion*, the lower lip. *Action*, to draw the lower lip downwards.

Levator menti.—Origin, alveoli of front teeth of the lower jaw. *Course*, downwards and forwards. *Insertion*, lower lip and contiguous tegument. *Action*, to raise the chin and lower lip.

Buccinator.—Origin, ridge between the last molar tooth and the coronoid process of the lower jaw and upper jaw between the last molar and the pterygoid process of the sphenoid bone. *Course*, horizontally forwards. *Insertion*, the corner of the mouth. *Action*, to draw the corner of the mouth backwards or outwards.

Masseter.—Origin, by an *outer* layer, from the tuberosity of the upper jaw-bone, the lower edge of the malar bone and the zygoma; by an *inner* layer, from the posterior surface of the zygoma. *Course*, outer layer, downwards and backwards; inner layer, downwards and forwards. *Insertion;* outer plane, ramus and angle of the lower jaw; inner plane, coronoid process of the same bone. *Action*, to draw up the lower jaw. The outer plane or layer acting alone, protrudes the jaw; the inner alone draws it backwards.

Temporalis.—Origin, the side of the head from the lower part of the parietal bone to the zygoma. *Course*, downwards and somewhat forwards. *Insertion*, tendinous, passing under the zygoma, into the coronoid process of the lower jaw.

Pterygoideus internus.—Origin, fossa formed by the internal face of the pterygoid process of the sphenoid and palate bones. *Course*, downwards and outwards. *Insertion*, inner face of the angle of the lower jaw. *Action*, to close the jaw, or, if one acts at a time, to give it a lateral grinding motion.

Pterygoideus externus.—Origin, outside of the pterygoid process of the sphenoid bone, and its spinous and temporal processes. *Course*, outwards and a little backwards. *Insertion*, neck of the lower jaw. *Action*, to draw the lower jaw forwards; or, when the two act alternately, to produce an oblique or grinding motion.

Hyo-glossus.—Origin, hyoid bone. *Course*, upwards and outwards. *Insertion*, side of the tongue. *Action*, to depress the side of the tongue, making its dorsum convex.

Genio-hyo-glossus.—Origin, back of the chin. *Course*, fan-like, backwards, to the middle of the tongue and hyoid bone. *Insertion*, the whole length of the tongue, and the base of the hyoid bone. *Action*, according to the fibres of it engaged, to draw the tongue forwards, backwards, or downwards; or, to draw the os hyoides forwards and upwards.

Stylo-glossus.—Origin, styloid process of the temporal bone. *Course*, in slender rounded mass, downwards and forwards. *Insertion*, root and side of the tongue. *Action*, to draw the tongue backwards and sideways.

Lingualis.—Origin, the side of the root of the tongue. *Course*, forwards, between the hyo-glossus and the genio-hyo-glossus. *Insertion*, apex of the tongue. *Action*, to raise the apex of the tongue, shorten it and curve it backwards.

Other muscles of the substance of the tongue will be described hereafter with it.

Circumflexus palati.—Origin, spinous process of sphenoid bone, Eustachian tube, and internal pterygoid process of sphenoid. *Course*, over the hook of the internal plate of the pterygoid process as a pulley, after which it widens. *Insertion*, velum palati (soft

palate), and edge of palate bones. *Action*, to extend the velum palati.

Levator palati.—Origin, apex of petrous portion of temporal bone, and Eustachian tube. *Course*, downwards, forwards, and inwards. *Insertion*, into the soft palate as far as the uvula. *Action*, to raise the soft palate and draw it backwards.

Constrictor isthmi faucium.—Origin, side of the tongue near its roots. *Course*, upwards between the folds of the anterior half arch of the palate. *Insertion*, soft palate at the base of the uvula. *Action*, to bring the tongue and palate together, and close the opening from the mouth into the pharynx.

Palato-pharyngeus.—Origin, posterior half arch of the palate. *Course*, downwards, in a curve, the convexity outwards. *Insertion*, upper and back edge of the thyroid cartilage, and the pharynx between its middle and lower constrictor muscles. *Action*, to depress the palate and force it down over the pharynx.

Azygos uvulæ.—Origin, spinous process of the palatal suture. *Course*, downwards. *Insertion*, the whole length of the uvula. *Action*, to contract the uvula and draw it upwards.

MUSCLES OF THE NECK.

Platysma myoides.—Origin, connective tissue below the clavicle. *Course*, flat and thin (with pale and imperfectly developed fibres), upwards under the skin of the front and side of the neck. *Insertion*, the side of the lower jaw and skin of the face. *Action*, rudimentary or almost *null* in man; in the ox, horse, etc., as the *cutaneous muscle*, to shake forcibly the skin of the neck. If it act in man, it must draw down the jaw or lower lip, or raise the skin of the neck.

Sterno-cleido-mastoideus.—Origin, upper end of sternum, and sternal end of clavicle. *Course*, by two separate heads, at first, which, not far above the clavicle, join into one muscle, to pass obliquely upwards and outwards. *Insertion*, mastoid process of the temporal bone. *Action*, if only one contracts, to draw the head down to one side; if both act together, to draw the head down toward the chest.

Digastricus.—Origin, the mastoid process. *Course*, first fleshy, downwards and forwards, then tendinous through a perforation in the stylo-hyoideus muscle, then fleshy again, upwards and forwards. *Insertion*, base of lower jaw at its median line or symphysis. *Action*, to draw the jaw down and open the mouth; or, to raise the hyoid bone and throat.

Stylo-hyoideus.—Origin, styloid process of temporal bone. *Course*, downwards and forwards, perforated by the *digastricus*. *Insertion*, os hyoides. *Action*, to raise the hyoid bone and draw it backwards.

Mylo-hyoideus.—Origin, broad and thin from inside of lower jaw, from the middle of the chin to the last molar tooth. *Course*, downwards and forwards. *Insertion*, os hyoides. *Action*, to draw the os hyoides upwards and forwards, and protrude the tongue. It forms the floor of the mouth.

Genio-hyoideus.—Origin, tubercle inside of lower jaw near its

middle line. *Course*, downwards and backwards. *Insertion*, os hyoides. *Action*, to raise the hyoid bone and draw it forwards.

Omo-hyoideus.—Origin, upper margin of scapula. *Course*, obliquely upwards and forwards, as a long, slender muscle, tendinous where it passes under the sterno-cleido-mastoid. *Insertion*, os hyoides. *Action*, to draw down the hyoid bone, or draw it to one side.

Sterno-hyoideus.—Origin, first bone of the sternum, part of clavicle, and cartilage of first rib. *Course*, upwards. *Insertion*, os hyoides. *Action*, to draw down the hyoid bone.

Sterno-thyroideus.—Origin, margin of first bone of sternum, and cartilage of first rib. *Course*, upwards on the front and side of the trachea and thyroid gland. *Insertion*, lower edge of the thyroid cartilage. *Action*, to draw the larynx downwards.

Thyro-hyoideus.— Origin, side of thyroid cartilage. *Course*, upwards. *Insertion*, base and corner of os hyoides. *Action*, to approximate the thyroid cartilage and hyoid bone.

Constrictor pharyngis inferior.—Origin, sides of thyroid and cricoid cartilage of the larynx. *Course*, superior fibres, obliquely upwards, covering part of the constrictor medius; inferior fibres, horizontally, over the upper part of the œsophagus. *Insertion*, meeting its fellow of the opposite side at the median line of the back of the pharynx. *Action*, to constrict the lower portion of the pharynx and draw it upwards and backwards.

Constrictor pharyngis medius.—Origin, corner of os hyoides and ligament between it and the thyroid cartilage. *Course*, spreading, and dividing into two terminal portions. *Insertion*, into its fellow at the back of the pharynx, and into the cuneiform process of the occiput, before the foramen magnum. *Action*, to constrict the middle of the pharynx, and to draw the hyoid bone upwards and backwards.

Constrictor pharyngis superior.—Origin, cuneiform process of occiput, pterygoid process of sphenoid bone, and upper and lower jaws near the last molar tooth; also, the buccinator muscle, palate, and root of the tongue. *Course*, almost horizontal, its lower edge covered by the constrictor medius. *Insertion*, meeting its fellow at the median line of the pharynx behind. *Action*, to constrict the upper portion of the pharynx.

Stylo-pharyngeus.—Origin, styloid process. *Course*, downwards and forwards. *Insertion*, the side of the pharynx between the upper and middle constrictors, and into the posterior edge of thyroid cartilage. *Action*, to raise the pharynx and larynx, and open the pharynx above.

The muscles belonging to the *larynx* itself have been described in the account of it as a part of the apparatus of respiration.

Longus colli.—Origin, sides of the bodies of the three upper dorsal vertebræ, and transverse processes of four lower cervical vertebræ. *Course*, upwards and slightly forwards. *Insertion*, front of bodies of all the vertebræ of the neck. *Action*, to bend the neck forwards or to one side.

Rectus capitis anticus major.—Origin, transverse processes of third, fourth, fifth, and sixth vertebræ of the neck. *Course*, up-

wards and a little inwards. *Insertion*, cuneiform process of occiput, in front of condyle. *Action*, to depress the head.

Rectus capitis anticus minor.—Origin, front of the atlas. *Course*,

Fig. 81.

MUSCLES—BACK VIEW.—The fascia is left upon the left limbs, removed from the right.

upwards. *Insertion*, occiput in front of condyle. *Action*, to depress or bow the head.

Rectus capitis posticus major.—Origin, spinous process of the second cervical (axis or dentata) vertebra. *Course*, obliquely upwards, widening as it ascends. *Insertion*, inferior semicircular ridge of the occiput. *Action*, to draw back or rotate the head.

Rectus capitis posticus minor.—Origin, posterior tubercle of the atlas vertebra. *Course*, obliquely upwards, widening as it ascends. This muscle is *within* the last described, the two *minors* being thus between the two *majors*. *Insertion*, occiput, along part of the semicircular ridge and the space between it and the foramen magnum. *Action*, to draw the head backwards.

Obliquus capitis inferior.—Origin, spinous process of vertebra dentata. *Course*, upwards and outwards. *Insertion*, transverse process of atlas. *Action*, to rotate the atlas, and head upon it, on the axis.

Obliquus capitis superior.—Origin, transverse process of the atlas. *Course*, upwards and slightly inwards. *Insertion*, outer end of the lower semicircular ridge of the occiput. *Action*, to draw the head backwards.

Rectus capitis lateralis.—Origin, transverse process of the atlas. *Course*, obliquely upwards. *Insertion*, occiput outside of the condyle. *Action*, to draw the head to one side.

Scalenus anticus.—Origin, first rib near its cartilage. *Course*, upwards, inwards, and backwards. *Insertion*, transverse processes of the fourth, fifth, and sixth vertebræ of the neck, by three separate tendons. *Action*, to draw the neck to one side, or lift the first rib.

Scalenus medius.—Origin, first rib, upper and outer part. *Course*, upwards, inwards, and backwards; separated from the scalenus anticus below by the subclavian artery, above by the cervical nerves. *Insertion*, by separate tendons, into the transverse processes of all the cervical vertebræ. *Action*, to draw the neck to one side, or lift the rib.

Scalenus posticus.—Origin, second rib near its tubercle. *Course*, upwards, inwards, and backwards. *Insertion*, transverse processes of fifth and sixth cervical vertebræ. *Action*, like that of the two preceding muscles.

Trapezius.—Origin, occipital protuberance, spinous processes of five first vertebræ of the neck, by the ligamentum nuchæ, and spinous processes of two last cervical and all the dorsal vertebræ. *Course*, by *converging* fibres, some downwards, some horizontally, and others upwards, the whole outwards. *Insertion*, outer half of the clavicle, the acromion process, and whole length of spine of the scapula. *Action*, according to its partial or total contraction, to draw the shoulder upwards, backwards, or downwards; or, if the upper portion act when the shoulder is fixed, to draw the head to one side. This muscle is just beneath the skin, covering the other dorso-cervical muscles.

Rhomboideus major.—Origin, spinous processes of the last cervical and first four dorsal vertebræ. *Course*, downwards and outwards. *Insertion*, the whole base of the scapula, below its spine. *Action*, to draw the scapula upwards and backwards.

Rhomboideus minor.—*Origin*, spinous processes of three lower cervical vertebræ. *Course*, obliquely downwards and outwards. *Insertion*, base of the scapula opposite its spine. *Action*, same as that of rhomboideus major.

Levator scapulæ.—*Origin*, from transverse processes of four or five upper cervical vertebræ, by distinct tendons. *Course*, downwards and outwards. *Insertion*, base of the scapula above the spine. *Action*, to raise the scapula.

Cervicalis descendens.—*Origin*, upper margin of first four ribs, by as many tendons. *Course*, upwards and inwards. *Insertion*, transverse processes of fourth, fifth, and sixth cervical vertebræ. *Action*, to draw the neck backwards.

Splenius.—*Origin*, spinous processes of the five lower cervical and four upper dorsal vertebræ. *Course*, upwards and outwards. *Insertion*, into transverse processes of three or four cervical vertebræ; and also, into the mastoid process and occiput.

Complexus.—*Origin*, four lower cervical and seven upper dorsal vertebræ, and spinous process of first dorsal. *Course*, upwards. *Insertion*, on the inner side of splenius, into the occiput, between the upper and lower semicircular ridges. *Action*, to draw the head backwards or to one side.

Trachelo-mastoideus.—*Origin*, transverse processes of five lower cervical and three upper dorsal vertebræ. *Course*, upwards and outwards. *Insertion*, mastoid process. *Action*, same as that of the complexus.

MUSCLES OF THE TRUNK.

Pectoralis major.—*Origin*, sternal half of clavicle, whole length of upper and middle bones of the sternum, and cartilages of fifth and sixth ribs. *Course*, outwards, converging, and downwards to the axilla. *Insertion*, by a flat, broad, twisted tendon, into the humerus, in front of the bicipital groove. *Action*, to draw the arm inwards and forwards, or downwards if raised. This muscle lies under the skin.

Pectoralis minor.—*Origin*, third, fourth, and fifth ribs near their cartilages. *Course*, upwards and outwards, converging; it lies beneath the pectoralis major. *Insertion*, coracoid process of the scapula. *Action*, to depress the shoulder; or, to raise the ribs.

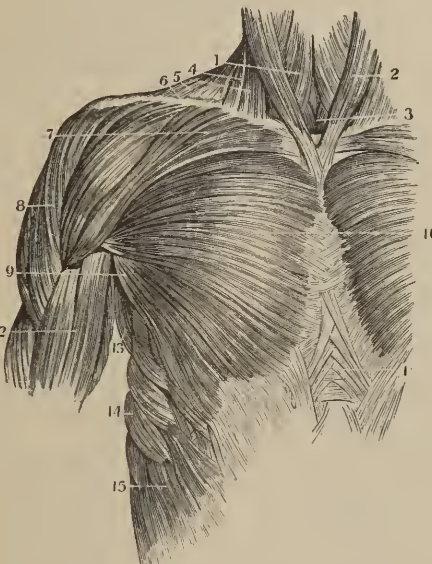
Subclavius.—*Origin*, cartilage of the first rib. *Course*, outwards, under the clavicle. *Insertion*, under margin of the clavicle almost its whole length. *Action*, to draw the clavicle downwards.

Serratus magnus, vel *anticus.*—*Origin*, by tooth-like digitations, from the first nine ribs. *Course*, upwards and backwards, in front of and beneath the subscapularis. *Insertion*, whole length of the base of the scapula. *Action*, to draw the scapula forwards and downwards, or to raise the ribs.

Intercostales, *externi* et *interni.*—*Origin*, lower margin of each rib except the last. *Course*, oblique; the fibres of the external intercostals going downwards and forwards, those of the internal downwards and backwards, so as to cross each other. *Insertion*, upper edge of each rib except the first. *Action*, to elevate the ribs. The lower ones may, instead, depress the ribs in forced expiration.

Also, the middle and posterior portions of the *interni* may draw down the ribs; the principal elevation of the ribs is ascribed to the *external* intercostals. Between the two layers or sets of muscles pass the intercostal vessels and nerves. In contact with their inner surface is the pleura.

Fig. 82.



SUPERIOR MUSCLES OF THE UPPER FRONT OF THE TRUNK.—1. Sterno-hyoid. 2. Sterno-cleido-mastoid. 3. Sterno-thyroid. 4. Sterno-cleido-mastoid. 5. Edge of the trapezius. 6. Clavicle. 7. Clavicular origin of the pectoralis major. 8. Deltoid. 9. Fold of pectoralis major on the anterior edge of the axilla. 10. Middle of the pectoralis major. 11. Crossing and interlocking of fibres of the external oblique of one side with those of the other. 12. Biceps flexor cubiti. 13. Teres major. 14 Serratus major anticus. 15. Superior heads of external oblique interlocking with serratus major.

Sterno-costalis.—Origin, middle and last piece of the sternum. *Course*, upwards and outwards. *Insertion*, cartilages of third, fourth, and fifth, and sometimes sixth ribs. *Action*, to draw down the ribs and diminish the cavity of the chest.

Levatores costarum.—Origin, transverse processes of the last cervical and eleven upper dorsal vertebræ. *Course*, downwards and outwards, twelve in number on each side. *Insertions*, into the rough surfaces of the ribs between their tubercles and angles. *Action*, to elevate the ribs.

Diaphragma major.—Origin, by fleshy slips from the ensiform

cartilage of the sternum, and from the inner face of the cartilages of the last six ribs. *Course*, converging, by all its fibres, to a broad central tendon. *Insertion*, into the cordiform tendon, which is notched in shape at the vertebral column, and pointed near the sternum. Through the *foramen quadratum*, near the spine, the vena cava ascends.

Diaphragma minor.—Origin, by four pairs of fleshy and tendinous slips, of which the longest arise from the third and fourth lumbar vertebræ. The second pair come from the ligament between the second and third lumbar vertebræ. The third pair from the sides of the second, and the fourth pair from the base of the transverse process of the same vertebra. *Course*, by muscular bands, upwards, in two columns, one on each side. *Insertion*, into the back and notch of the cordiform tendon. Through this muscle, the lesser diaghragm, pass, by one foramen (*œsophageum*), the œsophagus and pneumogastric nerve; through another (*hiatus aorticus*) the aorta, thoracic duct, and great splanchnic nerve. *Action*, that of the greater and lesser diaphragm, often described and generally named as one muscle, is, by *descending* in its contraction, to increase the cavity of the chest in inspiration. The diaphragm is also a septum or partition between the chest and the abdomen.

Obliquus externus abdominis.—Origin, by digitations from the last eight ribs, near their cartilages; in apposition to portions of the pectoralis major, serratus magnus, and latissimus dorsi. *Course*, downwards and inwards over the abdomen; a few fibres crossing the median line just above the pubes. This muscle is next beneath the skin and superficial fascia. *Insertion*, into the median line or *linea alba*, where it meets its fellow; into the anterior half of the crest of the ilium; anterior superior spine of the ilium, and pubes at and near the symphysis. The tendinous cord which reaches from the spine of the ilium to the pubes is called *Poupart's ligament*. This divides into two bands anteriorly, one passing to the symphysis and the other to the spine of the pubes. The latter is reflected outwards and backwards along the *linea ileo-pectinea* for about an inch; the reflection being called in surgical anatomy *Gimbernat's ligament*. *Action*, to sustain and compress all the contents of the abdomen and force them upwards towards the diaphragm, or downwards towards the perineum.

Obliquus internus, vel *Ascendens abdominis.—Origin*, posterior face of sacrum, spinous processes of three lower lumbar vertebræ, crista of the ilium, and Poupart's ligament. *Course*, upwards and inwards to the *linea semilunaris*, where the tendon separates into an anterior and posterior layer. The former joins the tendon of the obliquus externus and passes in front of the *rectus* muscle to the linea alba. The posterior layer joins the tendon of the *transversalis* muscle to go behind the rectus; except that, from about half way between the umbilicus and the pubes downwards, it passes with the anterior portion in front of the rectus muscle. *Insertion*, into the six lower ribs at their cartilages, the side of the ensiform cartilage, and the *linea alba* or median vertical tendinous line of the abdominal superficies. *Action*, the same as that of the external oblique.

Transversalis abdominis.—Origin, cartilages of six or seven lower ribs, transverse processes of the last dorsal and upper four lumbar vertebræ, almost the whole length of the crest of the ilium, and anterior half of Poupart's ligament. *Course*, across the front of the abdomen. *Insertion*, into the whole length of the linea alba. *Action*, like that of the last two muscles.

Rectus abdominis.—Origin, anterior face of ensiform cartilage, and cartilages of the fifth, sixth, and seventh ribs. *Course*, downwards on each side of the linea alba, in a flat band about three inches in width, narrowing below and becoming tendinous. *Insertion*, the pubes, at and near the symphysis. *Action*, to compress the contents of the abdomen, or to bend the body or raise the anterior part of the pelvis.

The *linea semilunaris* is a white curved line, with the convexity outwards, extending, on each side, downwards from the cartilage of the eighth rib to the pubes. It is formed by the tendon of the internal oblique muscle at its division.

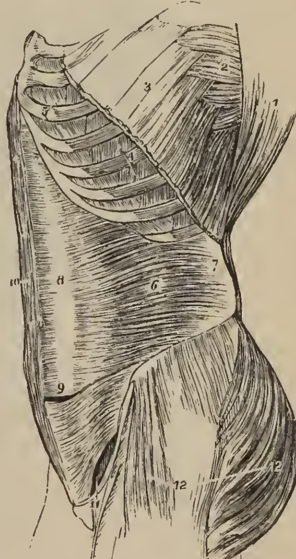
The *lineæ transversæ* are three or four tendinous lines crossing the rectus muscle at right angles to the direction of its fibres at the distance of a few inches from each other.

The anatomy of hernia will be given by itself hereafter.

Pyramidalis.—This muscle is often absent. *Origin*, upper margin of the pubes. *Course*, upwards, in a pyramidal form, within the sheath of the rectus. *Insertion*, the linea alba and inner edge of the rectus. *Action*, to make tense the rectus muscle, and support the lower part of the abdomen.

Quadratus lumborum.—Origin, posterior and upper margin of ilium, for two inches from the spine. *Course*, upwards and inwards. *Insertion*, into the transverse processes of all the lumbar and the side of the last dorsal vertebræ, and into the last rib near the spine. *Action*, to move

Fig. 83.



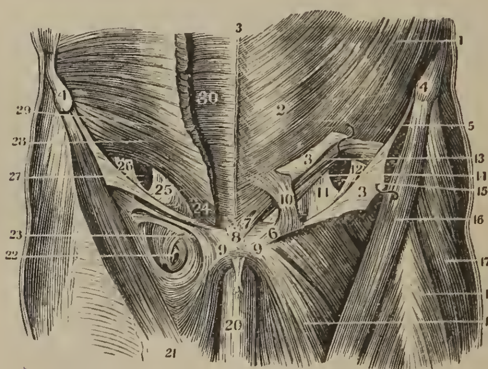
Lateral view of the Muscles of the Trunk.—1. Latissimus dorsi. 2. Serratus major anticus. 3. External oblique. 4. Two external intercostal muscles. 5. Two internal intercostal muscles. 6. Transversalis abdominis. 7. Fascia lumborum. 8. Sheath of the rectus. 9. Rectus abdominis, cut off. 10. Rectus abdominis of right side. 11. Crural arch. 12. Gluteus magnus—medius and tensor vaginæ femoris covered by the fascia lata.

the loins to either side, or if both act, to move the pelvis forward. It may also depress the last rib.

Psoas magnus.—Origin, bodies and transverse processes of the last dorsal and all the lumbar vertebræ. *Course*, in an oblong form downwards and forwards, under or behind Poupart's ligament and over the pubes. The peritoneum covers it in front. *Insertion*, into the trochanter minor, and an inch or so of the shaft of the femur. *Action*, to flex the thigh on the pelvis and rotate it a little outwards; or when the thigh is fixed, to bend the body forwards.

Psoas parvus.—Origin, sides of last dorsal and first lumbar vertebræ, and intevertebral ligament. *Course*, along the internal side of the psoas magnus. *Insertion*, linea ilio-pectinea at the junction of the pubes and ilium. *Action*, to bend the spine upon the pelvis, and to draw up the femoral vessels in their sheath.

Fig. 84.



Abdominal Muscles and Inguinal Canal.—1. External oblique muscle. 2. Its aponeurosis. 3. Its tendon slit up and turned back to show the canal. 4. Anterior superior spinous processes. 5. Poupart's ligament. 6. External column of external ring. 7. Internal column of external ring. 8 Intercrossing of the tendons of each side. 9. Body of the pubes. 10. Upper boundary of the external abdominal ring—the line points to the ring. 11, 12. Fascia transversalis. 13. Fibres of internal oblique turned up. 14. Fibres of transversalis muscle. 15. Internal ring enlarged for demonstration. 16. Sartorius. 17. Fascia lata femoris. 18. Rectus femoris. 19. Adductor longus. 20. Penis. 21. Fascia lata of the opposite thigh. 22. Point where the saphena vein enters the femoral. 23. Fascia lata as applied to the vessels. 24. Insertion of transversalis muscle. 25, 26. Fascia transversalis. 27. Poupart's ligament turned off from the internal muscles. 28. Transversalis abdominis. 29. Internal oblique. 30. Rectus abdominis.

Iliacus internus.—Origin, transverse process of the last lumbar vertebra, whole inner edge of crest of the ilium, and the same bone between the anterior superior spine and the acetabulum; also

from the whole *venter* or concavity of the ilium. *Course*, downwards, and somewhat forwards, over the edge of the pubes behind Poupart's ligament. *Insertion*, with the psoas magnus into the trochanter minor of the femur. *Action*, to flex the thigh upon the pelvis, or the body towards the thigh.

Latissimus dorsi.—Origin, spinous processes of the last seven dorsal and all of the lumbar vertebræ and the sacrum; also the outer margin of the sacrum and posterior part of the ilium, and the last four ribs. *Course*, by converging fibres, upwards and horizontally outwards, towards the axilla, passing over the inferior angle of the scapula. Except above, where the trapezius covers it, this muscle lies next under the skin. *Insertion*, by a flat, strong tendon, into the humerus just behind the bicipital groove. *Action*, to draw the arm downwards and backwards, and to roll it inwards.

Serratus posticus superior.—Origin, from the ligamentum nuchæ, over the last three cervical and two upper dorsal vertebræ. *Course*, obliquely downwards and outwards. *Insertion*, by fleshy slips, into the second, third, fourth, and fifth ribs, beyond their angles. *Action*, to raise the ribs.

Serratus posticus inferior.—Origin, lumbar fascia, and spinous processes of the last two dorsal and first three lumbar vertebræ. *Course*, upwards and outwards. *Insertion*, by fleshy slips, into the last four ribs, near their cartilages.

Interspinales.—Origin, in the *cerivical* and *lumbar* regions, from the upper part of each spinous process. *Course*, upwards, in quadrilateral form, but of small size. *Insertion*, each into the spinous process of the vertebra next above its origin. *Action*, to draw the spinous processes together, and sustain the spine in the erect position.

Transversalis cervicis.—Origin, transverse processes of five upper dorsal vertebræ. *Course*, upwards, between the splenius and the trachelo-mastoideus. *Insertion*, into the transverse processes of all the cervical vertebræ except the first and the last. *Action*, to draw the neck backwards or to one side.

Intertransversales.—Origin, each transverse process. *Course*, vertical. *Insertion*, the transverse process next above or below. *Action*, to bend the spine to one side.

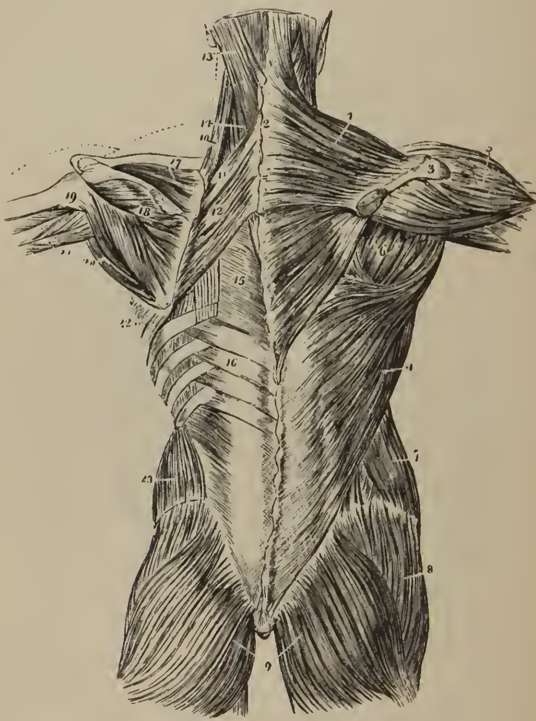
Semi-spinalis colli. Origin, transverse processes of first six dorsal vertebræ. *Course*, upwards. *Insertion*, spinous processes of all the cervical vertebræ except the first and last. *Action*, to draw the neck obliquely backwards.

Semi-spinalis dorsi.—Origin, transverse processes of the seventh, eighth, ninth, and tenth dorsal vertebræ. *Course*, upwards. *Insertion*, spinous processes of the last two cervical and five or six upper dorsal vertebræ.

Multifidus spinæ.—Origin, from back of the sacrum and adjacent part of crest of the ilium, from the oblique and transverse processes of all the lumbar vertebræ, and from the transverse processes of all the dorsal and the last four cervical vertebræ. *Course*, upwards and inwards. *Insertion*, last five or six cervical spinous processes, and all those of the dorsal and lumbar vertebræ. *Action*, to draw the spine backwards or to one side; or, both acting, to sustain the spine in the erect position.

Spinalis dorsi.—*Origin*, spinous processes of three lower dorsal and two upper lumbar vertebræ. *Course*, upwards. *Insertion*, into the spinous processes of eight or nine of the upper dorsal spinous processes, excluding the first. *Action*, to sustain the spine in the erect position.

Fig. 85.



Second Layer of Muscles of the Back.—1. Trapezius. 2. A portion of the tendinous ellipse formed by the trapezius on both sides. 3. Spine of scapula. 4. Latissimus dorsi. 5. Deltoid. 6. Infra-spinatus and teres minor. 7. External oblique. 8. Gluteus medius. 9 Gluteus magnus. 10. Levator scapulæ. 11. Rhomboideus minor. 12. Rhomboideus major. 13. Splenius capitis. 14. Splenius colli. 15. Portion of origin of latissimus dorsi. 16. Serratus inferior posticus. 17. Supra-spinatus. 18 Infra-spinatus. 19. Teres minor. 20. Teres major. 21. Long head of triceps extensor cubiti. 22. Serratus major anticus. 23 Internal oblique.

Longissimus dorsi.—*Origin*, from the back of the whole sacrum, the posterior part of the crest of the ilium, and the spinous and transverse processes of all the lumbar vertebræ. *Course*, upwards;

filling the space between the spine and the angles of the ribs. *Insertion*, into the transverse processes of all the dorsal vertebræ, and the lower edge of each rib, except the last two, near their tubercles. *Action*, to erect, or keep erect, the spinal column.

Sacro-lumbalis.—Origin, in common with the longissimus dorsi; and, also, by the *musculi accessorii*, from the last six or eight ribs. *Course*, obliquely upwards. *Insertion*, into the angles of all the ribs. *Action*, with the last two, to raise the trunk and to keep it erect. The three muscles are sometimes together called the erector spinæ.

Levator ani.—Origin, pubes near the symphysis and arch, and upper margin of thyroid foramen; spine of the ischium, and connected aponeurosis. *Course*, by converging fibres, downwards and inwards. *Insertion*, last two bones of the coccyx, semi-circumference of the rectum just above the sphincter ani, and the side of the prostate gland and membranous part of the urethra. *Action*, to form the floor of the pelvis, to dilate the anal orifice, and to retract the bowel after defecation.

Coccygeus.—Origin, spine of the ischium. *Course*, gradually expanding over the inside of the posterior sacro-ischiatic ligament, inwards and backwards. *Insertion*, into the whole length of the side of the os coccygis. *Action*, to draw forwards the coccyx, and to aid the levator ani in forming a floor to the pelvis.

Sphincter ani.—Origin, point of the os coccygis. *Course*, forwards and around the anus just beneath the skin. *Action*, to close the anus.

Cremaster.—Origin, by an *outer* and *inner* fasciculus: the former, from Poupart's ligament; the latter, from the spine of the pubes. *Course*, downwards, over the testis. *Insertion*, into the tunica vaginalis testis and scrotum. *Action*, to draw up the testis. The lower portion of this muscle is generally pale and indistinct.

Erector penis.—Origin, tuberosity of the ischium. *Course*, upwards, to surround the crus penis. *Insertion*, into the membrane of the corpus cavernosum. *Action*, to compress the corpus cavernosum and detain blood in it during erection.

Accelerator urinæ.—Origin, ramus of the pubes and crus penis. *Course*, downwards; broad and thin in form. *Insertion*, into the anterior median line of the bulb of the urethra, and also into the anterior margin of the sphincter ani. *Action*, to propel urine or semen into and along the urethra.

Transversus perinei.—Origin, tuberosity of the *ischium*. *Course*, across the perineum. *Insertion*, into the anterior margin of the sphincter ani. *Action*, to dilate the bulbous portion of the urethra; or, to hold it in its position.

Erector clitoridis, of the female.—*Origin* and *course* as in the *erector penis* of the male; *insertion*, into the clitoris; *action*, to assist in its erection.

Sphincter vaginæ, in the female.—*Origin*, anterior margin of the sphincter ani, and neighboring connective tissue. *Course*, around the orifice of the vagina. *Insertion*, into the clitoris, meeting its fellow of the other side. *Action*, to contract the external orifice of the vagina.

MUSCLES OF THE SHOULDER.

Supra-spinatus.—Origin, the whole fossa above the spine of the scapula, and the spine itself. *Course*, with a strong tendon, under the acromion process. *Insertion*, into the great tubercle of the humerus. *Action*, to raise the arm and turn it outwards.

Infra-spinatus.—Origin, spine of scapula and fossa infra-spinata. *Course*, with a strong tendon, under the acromion process. *Insertion*, into the great tubercle of the humerus, middle face. *Action*, to roll the humerus outwards and backwards, and to sustain it when raised.

Teres major.—Origin, inferior angle of scapula. *Course*, upwards and outwards, with the latissimus dorsi. *Insertion*, by a broad tendon, into the ridge at the inner margin of the bicipital groove of the humerus. *Action*, to draw the arm downwards and backwards, and to roll it inwards.

Teres minor.—Origin, same as *major*. *Insertion*, facet on head of humerus. *Action*, to rotate the head of the humerus outwards.

Subscapularis.—Origin, base and under surface of the scapula. *Course*, upwards and outwards, its fibres converging. *Insertion*, into the lesser tubercle of the head of the os humeri. *Action*, to draw down the arm and roll it inwards.

Deltoides.—Origin, outer third of the clavicle, acromion process, and inferior edge of spine of scapula opposite to the trapezius muscle. *Course*, converging to make a covering for the shoulder, and triangularly down upon the outside of the arm to near its middle. *Insertion*, into a rough surface near the centre of the humerus. *Action*, to raise the arm, and move it either forwards or backwards according to the fibres used.

MUSCLES OF THE ARM.

Coraco-brachialis.—Origin, coracoid process of the scapula. *Course*, downwards. *Insertion*, inner side of humerus near its middle. *Action*, to draw the arm upwards and forwards.

Biceps flexor cubiti.—Origin, by two heads: the longer, by a round slender tendon, from the upper margin of the glenoid cavity of the shoulder-joint; the shorter, from the coracoid process of the scapula. *Course*, the two heads uniting into a thick and long muscle, downwards upon the front of the humerus. *Insertion*, into the tubercle at the upper and anterior part of the radius. *Action*, to bend the forearm upon the arm.

Brachialis anticus.—Origin, from the middle of the front part of the humerus, on each side of the insertion of the deltoid. *Course*, downwards. *Insertion*, into a depression at the base of the coronoid process of the ulna. *Action*, to flex the forearm upon the arm.

Triceps extensor cubiti.—Origin, by three heads. The longest comes from the scapula near the glenoid cavity. The second head, from the back part of the upper end of the humerus. The third, from the inner side of the humerus near the insertion of the teres major. *Course*, the three heads uniting above the middle of the

humerus, downwards upon the back of the arm. *Insertion*, into the olecranon process, ridge of the ulna, and condyles of the humerus. *Action*, to extend the forearm.

MUSCLES OF THE FOREARM.

Anterior, Superficial Layer.

Pronator radii teres.—Origin, internal condyle of os humeri, and coronoid process of ulna. *Course*, obliquely across the forearm. *Insertion*, posterior part of the middle of the radius. *Action*, to roll the radius inwards, and *pronate* the hand or turn the palm backwards or downwards.

Flexor carpi radialis.—Origin, inner condyle of humerus, and upper front part of the ulna, between the pronator radii teres and the flexor digitorum sublimis. *Course*, downwards along the radius, ending in a long tendon which goes over the trapezium under the annular ligament of the wrist. *Insertion*, metacarpal bone of the forefinger, in front of its upper end. *Action*, to bend the hand at the wrist.

Palmaris longus.—Origin, inner condyle of humerus. *Course*, soon becoming tendinous, downwards. *Insertion*, annular ligament of the wrist, and palmar aponeurosis. *Action*, to aid in bending the hand, or to make tense the tegument of the palm.

Flexor carpi ulnaris.—Origin, inner condyle of humerus, olecranon process, and inner edge of ulna to within three or four inches of the wrist. *Course*, downwards. *Insertion*, pisiform bone, and base of metacarpal of little finger. *Action*, to bend the hand towards the ulna.

Flexor digitorum sublimis.—Origin, inner condyle of humerus, coronoid process of ulna, and upper front of radius. *Course*, downwards; dividing above the wrist into four bellies, each of which sends off a tendon; all the tendons pass under the annular ligament. *Insertions;* each tendon is attached to the second phalanx of a finger; being first *perforated* by the tendon of the flexor profundus. *Action*, to bend the finger at the second phalanx, and the hand on the forearm.

Fig 86.

OUTER LAYER OF MUSCLES ON THE FRONT OF THE FOREARM.—1. Biceps flexor cubiti. 2. Brachialis internus. 3. Triceps. 4. Pronator radii teres. 5. Flexor carpi radialis. 6. Palmaris longus. 7. Flexor sublimis digitorum 8. Flexor carpi ulnaris. 9. Palmar fascia. 10. Palmaris brevis muscle. 11. Abductor pollicis manus. 12. Flexor brevis pollicis manus. 13. Supinator longus. 14. Extensor ossis metacarpi pollicis.

Deep-Seated Anterior Layer.

Flexor digitorum profundus.—Origin, upper and outer part of ulna, coronoid process, interosseous ligament, and half way down the ulna. *Course*, beneath the sublimis, downwards; also, dividing above the wrist and giving off four tendons. *Insertions*, into the third phalanges of the fingers, perforating first the tendons of the sublimis.

Flexor longus pollicis.—Origin, front of radius below its tubercle, middle two-thirds of the same bone, and also the inner condyle of the humerus. *Course*, downwards. *Insertion*, base of second phalanx of the thumb. *Action*, to bend the last joint of the thumb, and aid in bending the hand.

Pronator quadratus.—Origin, from a ridge on the inner and under part of the ulna. *Course*, in quadrangular form, two inches wide, across the forearm. *Insertion*, into the front of the radius. *Action*, to pronate the forearm and hand.

Posterior Superficial Layer.

Extensor digitorum communis.—Origin, outer condyle of humerus, and contiguous fascia. *Course*, downwards, upon the back of the forearm, dividing above the wrist into four tendons, which pass under the annular ligament in a groove of the radius. *Insertions*, into the whole length of the posterior faces of the fingers. *Action*, to extend the fingers.

Extensor carpi ulnaris.—Origin, external condyle of humerus, middle of ulna, and fascia. *Course*, downwards, ending in a round tendon which passes through a groove on the back of the ulna. *Insertion*, into the base of the metacarpal of the little finger. *Action*, to extend the hand at the wrist.

Extensor minimi digiti.—Origin, in common with the extensor communis digitorum. *Course*, downwards, its tendon going through a separate ring of the annular ligament. *Insertion*, with that of the tendon of the extensor communis, into the back of the little finger. *Action*, to extend the little finger.

Anconeus.—Origin, back of the outer condyle of the humerus. *Course*, upper fibres, horizontally, lower ones obliquely, across the back of the forearm near the elbow. *Insertion*, into the olecranon and adjacent part of the ulna. *Action*, to aid in extending the forearm or to rotate it inwards.

Extensor carpi radialis longior.—Origin, humerus, just above the outer condyle. *Course*, downwards, along the back of the radius, and, by a long flat tendon, under the annular ligament. *Insertion*, metacarpal of the forefinger. *Action*, to extend or draw backward the wrist and hand.

Supinator radii longus.—Origin, the ridge of the humerus, above the outer condyle almost to the middle of the bone. *Course*, downwards, upon the outside of the radius. *Insertion*, into the radius, above its styloid process. *Action*, to place the hand in a vertical position, with the thumb upwards, between pronation and supination; also, to flex the forearm when in that position.

Extensor carpi radialis brevior.—Origin, outer condyle of humerus.

Course, downwards along the back of the radius. *Insertion*, metacarpal of the middle or second finger. *Action*, to extend the hand and wrist.

Posterior Deep-Seated Layer.

Supinator radii brevis.—*Origin*, external condyle of humerus, upper and outer part of ulnar and interosseous ligament. *Course*, obliquely downwards, over the outer edge of the radius. *Insertion*, upper and outer part of radius, and its tubercle. *Action*, to supinate the forearm and hand.

Extensor major pollicis.—*Origin*, back of ulna, above its middle, interosseous ligament, and adjacent part of radius. *Course*, downwards on the back of the radius. *Insertion*, second phalanx of the thumb. *Action*, to extend the last bone of the thumb.

Extensor minor pollicis.—*Origin*, back of ulna below its middle, and interosseous ligament. *Course*, downwards on the back of the radius. *Insertion*, first phalanx of the thumb. *Action*, to extend the first bone of the thumb.

Extensor ossis metacarpi pollicis.—*Origin*, posterior surface of the middle of the ulna, interosseous ligament and radius. *Course*, downwards, its tendon passing through a groove of the radius. *Insertion*, into the trapezium, and the metacarpal bone of the thumb. *Action*, to extend the metacarpal, and with it the whole thumb.

Indicator.—*Origin*, back of ulna near its middle, and interosseous ligament. *Course*, downwards. *Insertion*, with tendon of extensor communis, into the whole back of the forefinger. *Action*, to extend the forefinger, as in pointing.

MUSCLES OF THE HAND.

Abductor pollicis.—*Origin*, trapezium, trapezoid, and annular ligament. *Insertion*, base of first phalanx of thumb. *Action*, toward the thumb away from the forefinger.

Fig. 87.

OUTER LAYER OF MUSCLES ON THE BACK OF THE FOREARM.—1. Biceps Flexor. 2. Brachialis internus. 3. Triceps extensor. 4. Supinator radii longus. 5. Extensor carpi radialis longior. 6. Extensor carpi radialis brevior. 7. Tendinous insertions of these muscles. 8. Extensor communis digitorum. 9. Extensor communis digitorum. 10. Extensor carpi ulnaris. 11. Anconeus. 12. Flexor carpi ulnaris. 13. Extensor minor pollicis. 14. Extensor major pollicis. 15. Posterior annular ligament.

Opponens pollicis.—Origin, point of the trapezium, and the annular ligament. *Insertion*, radial side of metacarpal of the thumb. *Action*, to draw the metacarpal and thumb towards the palm of the hand.

Flexor brevis pollicis.—Origin, by two heads; one, from the trapezium and trapezoid; the other, from the magnum, unciform, and metacarpal of the middle finger. Between the two, passes the tendon of the flexor longus pollicis. *Insertions*, into the two sesamoid bones of the first joint of the thumb. *Action*, to flex the first phalanx of the thumb.

Adductor pollicis.—Origin, ulnar side of second metacarpal bone; its fibres converging thence towards the insertion. *Insertion*, base of first phalanx of thumb. *Action*, to draw the thumb towards the forefinger.

Palmaris brevis.—Origin, annular ligament of wrist in front, and palmar aponeurosis. *Insertion*, into the tegument on the inner side of the hand. *Action*, to draw up the skin on the palm.

Lumbricales.—Origin (four in number), each from the outside of a tendon of the flexor profundus digitorum. *Insertion*, with the tendons of the extensor communis, into the middle of the backs of the first phalanges of the fingers. *Action*, to hold in place the flexor and extensor tendons, and to flex the fingers.

Abductor minimi digiti.—Origin, pisiform bone and annular ligament. *Insertion*, inner side of first phalanx of little finger. *Action*, to remove the little finger from the next.

Adductor metacarpi minimi digiti.—Origin, hook of the unciform bone. *Insertion*, metacarpal of little finger. *Action*, to flex the little finger, and approximate it to the rest.

Flexor parvus minimi digiti.—Origin, hook of the unciform. *Insertion*, first phalanx of little finger. *Action*, to bend that finger.

Interossei.—These are seven in number; *three palmar* and *four dorsal*. They arise from the sides of the metacarpal bones, and are inserted, with the lumbricales, into the sides of the first phalanges. They all act either as adductors or abductors of the fingers, according to their position; sometimes assisting the *extensor communis digitorum.*

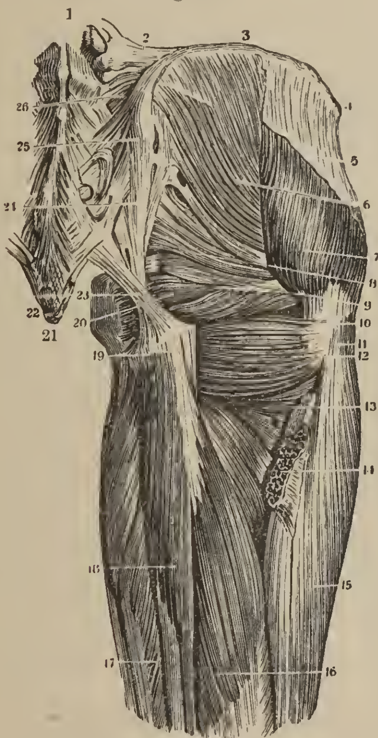
MUSCLES OF THE PELVIS AND THIGH.

Gluteus maximus.—Origin, from the posterior part of the crest of the ilium, and the dorsum near it; the side of the sacrum and coccyx; and the posterior sacro-sciatic ligament. *Course*, forwards and somewhat downwards, going over the great trochanter of the femur. *Insertion*, into the upper third of the linea aspera of the femur. *Action*, to draw the thigh backwards; or to maintain the balance of the body upon the lower extremity.

Gluteus medius.—Origin, anterior two-thirds of crest of ilium, and dorsum ilii between the crest and the semi-circular ridge. *Course*, under the gluteus maximus, converging to a broad strong tendon. *Insertion*, into the great trochanter and adjacent part of the shaft of the femur. *Action*, to draw the thigh backwards and outwards.

Gluteus minimus.—Origin, dorsum ilii between the semi-circular ridge and the hip-joint. *Course*, downwards, converging under the gluteus medius. *Insertion*, into the great trochanter. *Action*, to draw the thigh outwards and rotate it.

Fig. 88.



Deep-Seated Muscles on the Posterior Part of the Hip-Joint.—1. Fifth lumbar vertebra. 2. Ilio-lumbar ligament. 3. Crest of the ilium. 4. Anterior superior spinous process. 5. Origin of the fascia femoris. 6. Gluteus medius. 7. Its lower and anterior portion. 8. Pyriformis. 9. Gemini. 10. Trochanter major. 11. Insertion of the gluteus medius. 12. Quadratus femoris. 13. Part of the adductor magnus. 14. Insertion of the gluteus magnus. 15. Vastus externus. 16. Long head of the biceps. 17. Semi-membranosus. 18. Semi-tendinosus. 19. Tuber ischii. 20. Obturator internus. 21. Point of the coccyx. 22. Posterior coccygeal ligament. 23, 24. Greater sacro-sciatic ligament. 25. Posterior superior spinous process of ilium. 26. Posterior sacro-iliac ligaments.

Pyriformis.—Origin, anterior face of the sacrum. *Course*, in a conical form, leaving the pelvis through the sacro-sciatic foramen.

Insertion, into the great trochanter. *Action*, to rotate the thigh outwards.

Gemelli.—Origin, by two heads; one from the spine and the other from the tuberosity of the ischium. The tendon of the obturator goes between the two. *Course*, forwards and outwards. *Insertion*, into the great trochanter. *Action*, to rotate the thigh outwards.

Obturator internus.—Origin, from the margin of the thyroid foramen, except where the vessels pass through it. *Course*, converging to a round tendon which goes over the spine and tuberosity of the ischium as a pulley. *Insertion*, into the great trochanter. *Action*, to rotate the thigh outwards.

Obturator externus.—Origin, outer margin of the thyroid foramen. *Course*, converging outwards. *Insertion*, great trochanter. *Action*, to rotate the thigh outwards.

Quadratus femoris.—Origin, tuberosity of the ischium. *Course*, transversely outwards. *Insertion*, the ridge between the two trochanters. *Action*, to rotate the thigh outwards.

Sartorius.—Origin, anterior superior spinous process of the ilium. *Course*, downwards and inwards, crossing the length of the thigh; it being the longest muscle in the body. *Insertion*, inner side of the tubercle at the head of the tibia. *Action*, to bend the leg and draw it across the other.

Tensor Vaginæ femoris.—Origin, anterior superior spinous process of the ilium. *Course*, downwards and a little backwards. *Insertion*, into the fascia femoris on the outside of the thigh. *Action*, to make the fascia tense, and rotate the thigh inwards.

Rectus femoris.—Origin, anterior inferior spine of ilium, and from the same bone above the acetabulum. *Course*, downwards over the front of the thigh. *Insertion*, into the upper edge of the patella. *Action*, by the ligamentum patellæ, to straighten or extend the leg.

Cruræus.—Origin, front of femur and its sides to the linea aspera. *Course*, downwards upon the femur. *Insertion*, into the patella. *Action*, to extend the leg.

Vastus externus.—Origin, outer part of femur below the trochanter major, and the whole length of the linea aspera. *Course*, downwards on the outside of the thigh. *Insertion*, the patella. *Action*, to extend the leg.

Vastus internus.—Origin, front of femur and whole length of linea aspera. *Course*, downwards, on the inside of the thigh. *Insertion*, the patella. *Action*, to extend the leg.

The last four muscles are sometimes called, together, the *quadriceps femoris.*

Pectineus.—Origin, the upper part of the pubes, between the linea ilio-pectinea and the ridge above the thyroid foramen. *Course*, obliquely, in flattened form, downwards and outwards. *Insertion*, into the linea aspera, below the lesser trochanter. *Action*, to draw the thigh inwards and upwards, and to rotate it outwards.

Adductor longus. Origin, pubes near the symphysis. *Course*, downwards and outwards. *Insertion*, middle third of linea aspera. *Action*, to draw the thigh inwards and upwards.

Adductor brevis.—Origin, pubes, below the last named. *Course*,

downwards and outwards. *Insertion*, upper third of linea aspera. *Action*, as the adductor longus.

Adductor magnus.—Origin, body and ramus of pubes, and ramus of ischium. *Course*, downwards and outwards. *Insertion*, whole length of linea aspera, and internal condyle. *Action*, the same as the last two muscles.

Gracilis.—Origin, pubes near the symphysis. *Course*, downwards and outwards. *Insertion*, the tubercle of the tibia. *Action*, to flex the leg, and adduct the thigh.

Semi-tendinosus.—Origin, tuberosity of ischium. *Course*, downwards; becoming tendinous about four inches above the knee. *Insertion*, by a round tendon, into the inner side of the tibia, below its tubercle. *Action*, to bend the leg on the thigh.

Semi-membranosus.—Origin, tuberosity of the ischium. *Course*, downwards. *Insertion*, the inner and back part of the head of the tibia. *Action*, to bend the leg.

The three last-named muscles constitute the inner ham-string.

Biceps flexor cruris.—Origin, by two heads; one, from the tuberosity of the ischium; the other, from the linea aspera, high up. *Course*, downwards. *Insertion*, into the head of the fibula. *Action*, to bend the leg.

This muscle forms the outer hamstring.

MUSCLES OF THE LEG.

Tibialis anticus.—Origin, head of the tibia, and upper half of the inter-osseous ligament. *Course*, downwards upon the outer face of the tibia, sending its tendon over the astragalus in front of the internal malleolus. *Insertion*, the front of the internal cuneiform bone on the sole of the foot. *Action*, to raise the foot towards the leg, and turn the sole inwards.

Extensor longus digitorum.—Origin, head of the tibia, interosseous ligament, and head, and nearly the whole length of the fibula. *Course*, downwards, giving off four tendons which pass under the annular ligament. *Insertion*, each tendon into nearly the whole length of one of the toes, leaving out the great toe. *Action*, to extend the toes.

Extensor proprius pollicis pedis.—Origin, from the fibula, beginning three or four inches

Fig. 89.

MUSCLES OF THE BACK OF THE THIGH.—1. Gluteus medius. 2. Gluteus magnus. 3. Fascia lata. 4. Long head of biceps. 5. Short head of biceps. 6. Semi-tendinosus. 7, 7. Semi-membranosus. 8. Gracilis. 9. Adductor magnus. 10. Sartorius. 11. Popliteal space. 12. Gastrocnemius.

below its head. *Course*, downwards, its tendon going under the annular ligament. *Insertion*, into the whole length of the great toe. *Action*, to extend the great toe.

The last two muscles will also aid in raising the foot towards the front of the leg.

Peroneus longus.—Origin, head and shaft of the fibula to within three or four inches of the ankle. *Course*, downwards, its tendon passing through a groove in the external malleolus, the sinuosity of the os calcis, and a groove of the cuboid bone, to the middle of the sole. *Insertion*, outside of the base of the first metatarsal, and internal cuneiform bone. *Action*, to depress the foot and incline the sole outwards.

Peroneus brevis.—Origin, outside of fibula from just above its middle to the external malleolus. *Course*, downwards, through the same groove of the malleolus with the peroneus longus, and through a fossa on the outer surface of the os calcis. *Insertion*, base of metatarsal of the little toe. *Action*, same as peroneus longus.

Peroneus tertius.—Origin, middle of the fibula. *Course*, downwards to the outer malleolus, sending a tendon under the annular ligament. *Insertion*, base of metatarsal of the little toe. *Action*, to raise the foot towards the front of the leg.

Gastrocnemius.—Origin, by two heads; one from the inner condyle of the femur and ridge leading to the linea aspera; the other from the outer condyle and adjacent ridge. *Course*, as a double-bellied muscle, downwards, forming the outer part of the calf of the leg. *Insertion*, with the next muscle, by the tendo Achillis, into the os calcis, behind and below. *Action*, to raise the heel, and thus depress the foot; this action is called, in anatomy, the *extension* of the foot.

Soleus.—Origin, beneath the last named, by two heads; one from the head and upper part of the fibula, the other from the back of the tibia, for some inches, below the popliteus muscle. *Course*, downwards to the Achilles tendon. *Insertion*, with the gastrocnemius, into the os calcis.

Plantaris.—Origin, external condyle

Fig. 90.

MUSCLES OF THE FRONT OF THE LEG.—1. Tendon of quadriceps. 2. Spine of tibia. 3. Tibialis anticus. 4. Extensor communis digitorum. 5. Extensor proprius pollicis. 6. Peroneus tertius. 7. Peroneus longus. 8. Peroneus brevis. 9, 9. Soleus. 10. Gastrocnemius. 11. Extensor brevis digitorum.

of femur, and capsular ligament of the knee. *Course*, soon becoming tendinous and slender, downwards. *Insertion*, os calcis, below the tendo Achillis. *Action*, to depress or extend the foot. It is a feeble muscle, and sometimes absent.

Popliteus.—Origin, external condyle of femur, and capsular ligament of the knee. *Course*, inwards and downwards behind the knee. *Insertion*, a ridge at the inner and upper part of the tibia just below its head. *Action*, to bend the leg slightly, and rotate it inwards, and to draw tense the capsular ligament.

Flexor longus pollicis pedis.—Origin, back of the tibia, from about three inches below the head, almost to the ankle. *Course*, downwards, through a groove in the back of the tibia and of the astragalus. *Insertion*, into the last phalanx of the great toe. *Action*, to flex the great toe.

Flexor longus digitorum pedis.—Origin, back and inside of tibia from below the popliteus almost to the ankle; also from the outer edge of the tibia above the ankle. *Course*, downwards, in contact with the tibialis posticus; its tendon passing behind the inner malleolus, and through the sinuosity of the os calcis to the middle of the sole of the foot. There it receives a slip from the flexor longus pollicis, and divides into four tendons, which perforate those of the flexor brevis digitorum. *Insertion*, each tendon into the last phalanx of one of the four lesser toes. *Action*, to flex the toes and depress or extend the foot.

Tibialis posticus.—Origin, upper front of tibia, and, going through the interosseous ligament, also from the back of the tibia and fibula most of their length. *Course*, downwards, the tendon going through a groove of the inner malleolus. *Insertion*, inner face of os naviculare, and under surface of the tarsus, one slip reaching to the middle metatarsal bone. *Action*, to extend or depress the foot and turn the toes inwards.

Extensor brevis digitorum pedis.—Origin, front and outer part of the os calcis. *Insertion*, by four tendons, into all the toes but the last, under the insertions of the extensor longus digitorum. *Action*, to extend the toes.

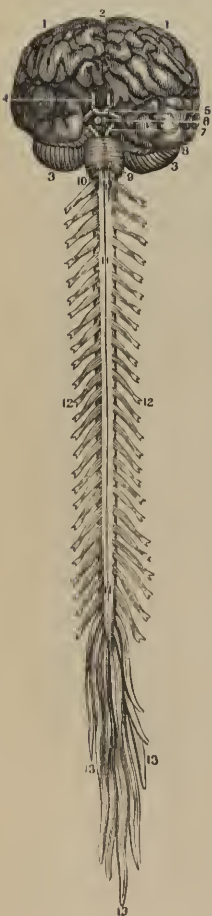
Flexor brevis digitorum pedis.—Origin, great tuberosity of os calcis, and plantar aponeurosis. *Insertion*, by four tendons, perforated by those of the flexor longus, into the second phalanges of the four lesser toes. *Action*, to flex the toes.

The remaining muscles of the foot are small, and similar to the corresponding ones in the hand; so that their description may be here omitted. Their names are as follows: four *dorsal* and three *plantar interossei*, abductors and adductors of the toes; *abductor pollicis pedis*, *abductor minimi digiti*, *flexor accessorius*, four *lumbricales pedis*, *flexor brevis pollicis*, *adductor pollicis pedis*, *flexor brevis minimi digiti*, *transversalis pedis*.

CHAPTER IX.

NERVOUS SYSTEM.

Fig. 91.



Portions.—Cerebro-spinal axis, ganglia, and nerves.

Minute Structure.—Two sorts of nervous tissue exist; the *white* (fibrous or) *tubular*, and the (cineritious or) *gray*, *vesicular*. The former is seen in the proper tubular fibres, prevailing in the cerebro-spinal system, and the gelatinous fibres, most common in the ganglionic system. In the *tubular*, under the microscope, the nerve is seen to consist of the central transparent *axis cylinder*, and the peripheral *white substance of Schwann*. In the *gelatinous* fibres, the white substance is almost absent. The diameter of the tubular fibres is about $\frac{1}{2500}$ of an inch. The gelatinous are less than half as large.

Vesicular neurin or nerve-substance is found in the brain and ganglia. It is formed of cells, each with a nucleus or central vesicle, and within that a clear nucleolus. Some are small and round or oval; others larger, and caudated or stellated, the processes sometimes dividing into minute branches.

Chemical Composition.—Nervous tissue contains albumen, or an albuminoid material, with fatty matter (cerebric and oleophosphoric acids, cholesterin, olein, and palmitin) and salts (phosphates and lactates).

Connections and Terminations.—Doubt yet exists as to these. Sometimes, at the centres or ganglia, a nerve-tube seems to di-

Anterior View of the Brain and Spinal Marrow.—1, 1. Hemispheres of the cerebrum. 2. Great middle fissure. 3. Cerebellum. 4. Olfactory nerves. 5. Optic nerves. 6. Corpora albicantia. 7. Motor oculi nerves. 8. Pons Varolii 9. Fourth pair of nerves. 10. Lower portion of the medulla oblongata. 11, 11. Medulla spinalis in its whole length. 12, 12. Spinal nerves. 13. Cauda equina.

late and receive a nerve-cell or corpuscle within it. The processes of caudate vesicles are described as extending into nerves. Whether nerves ever terminate, peripherally, by free ends, or always by loops or meshes, is undecided. Beale insists that every nerve filament makes part of a completed *circuit.*

Nerves are round or flattened cords, each containing a number of filaments or tubules inclosed in a sheath (neurilemma), and connecting a nerve-centre with some other part. In their course, they branch frequently, and sometimes form *plexuses;* but no two filaments ever truly unite or inosculate.

THE BRAIN.

Membranes.

These are, the *dura mater*, *arachnoid*, and *pia mater*.

The *dura mater* is a thick fibrous membrane, with a smooth epithelial lining. It adheres to the skull, especially at its base and along the sutures; and is continuous with the dura mater of the spinal cord, and with the sheath of the optic and other cephalic nerves. Three *processes* pass inwards from it; the falx cerebri, falx cerebelli, and the tentorium. The *falx cerebri* descends vertically between the hemispheres of the brain. In front, it connects with the crista galli of the ethmoid bone; behind, it widens, and joins the tentorium. Above, it is broad, containing the longitudinal sinus. In its lower curved edge is the inferior longitudinal sinus.

The *falx cerebelli* is a smaller triangular process, between the two lobes of the cerebellum. It passes from the under and posterior part of the tentorium to the occiput.

The *tentorium* is an arched layer of dura mater covering the cerebellum, beneath the posterior lobes of the cerebrum. It is connected behind with the occiput, at the sides with the temporal bones, and on its middle line above, with the edge of the falx cerebri. The anterior border is free and concave, with a large oval passage for the crura cerebri.

The *arteries* of the dura mater are, principally, the anterior meningeal arteries, from the ethmoidal and internal carotid; middle and small meningeal, from the internal maxillary; the posterior meningeal branch of the occipital, and the posterior meningeal from the vertebral.

Its *veins*, which, like its arteries, are also those of the contiguous bones, anastomose with the diploic veins, terminating in the sinuses, with two minor exceptions, which attend the middle meningeal artery.

The *nerves* of the dura mater are the recurrent of the fourth, and filaments from the ophthalmic, ganglion of Casser, and sympathetic.

Glandulæ Pacchioni are small whitish granulations found on both the outer and inner surfaces of the dura mater, near the superior longitudinal sinus, and on the pia mater of the same region. They are fibro-cellular in structure; absent in infancy,

they increase gradually in number after the seventh year; but are sometimes wanting.

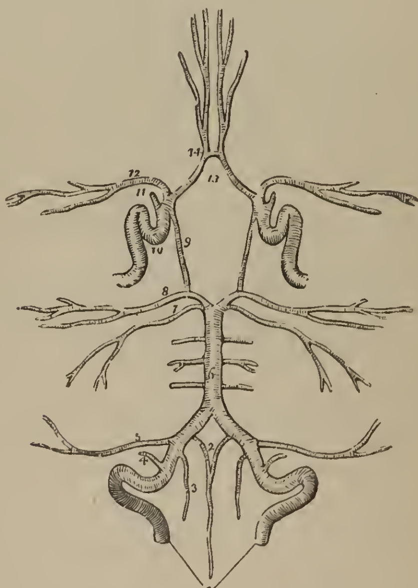
Arachnoid Membrane.

This is the middle serous membrane of the brain, described by most anatomists as double, one layer lining the dura mater, and the other investing the brain. It is very thin; thickest at the base of the hemispheres. It does not descend between the convolutions, but passes over them. The *sub-arachnoid space* is between the arachnoid and the pia mater. It contains the serous *cerebro-spinal fluid.*

Pia Mater.

A fine but extended plexus of bloodvessels, held together by delicate connective tissue, investing the whole brain, and dipping

Fig. 92.



Arteries of the Brain and Circle of Willis.—1. Vertebral arteries. 2. Anterior spinal branches uniting to form a single vessel. 3. Posterior spinal artery. 4. Posterior meningeal artery. 5. Inferior cerebellar artery. 6. Basilar artery giving off transverse branches. 7. Superior cerebellar artery. 8. Posterior cerebral artery. 9. Posterior communicating branch of the internal carotid. 10. Internal carotid artery, showing its curves within the skull. 11. Ophthalmic artery divided. 12. Middle cerebral artery. 13. Anterior cerebral arteries connected by—14. Anterior communicating artery.

between the convolutions, receives this name. The pia mater is extended into the interior of the cerebrum, making the velum interpositum and the choroid plexuses of the fourth ventricle. Some long straight vessels pass from it through the white substance.

Brain or Encephalon.

We divide this into the *cerebrum*, *cerebellum*, *medulla oblongata*, and *pons Varolii*. The average weight of the whole mass in the adult male is nearly fifty ounces; in the female, less than forty-five ounces. The maximum is about sixty-five ounces. Up to nearly forty years of age, in both sexes, it increases; after that, it loses about an ounce of weight with each ten years of age.

Cerebrum.

As no description can enable the student to understand the anatomy of the brain without repeated *dissections*, we shall attempt but a very brief statement—especially of the terms applied to its parts.

The cerebrum is an ovoidal mass, divided into the right and left *hemispheres;* which are partly separated by the great longitudinal fissure. The surface of each hemisphere, under the pia mater, is marked by *convolutions;* these being different in different brains, and even upon the two hemispheres in the same subject. Gray vesicular nerve-substance predominates in the convolutions, although alternating thin layers of white substance exist.

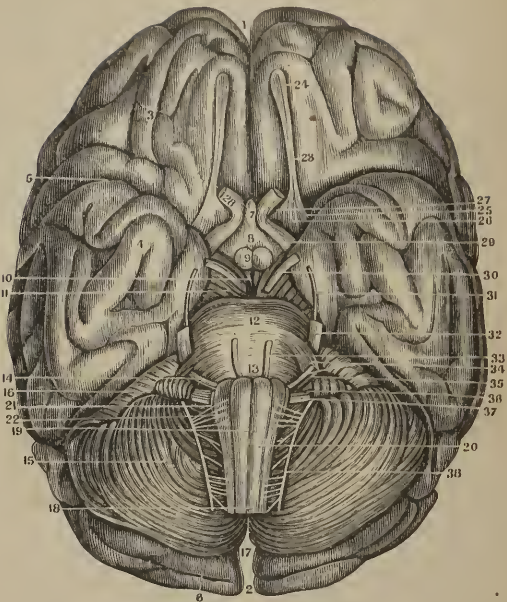
The base of each hemisphere presents a division into the *anterior*, *middle*, and *posterior lobes*. The *fissure of Sylvius*, on each side, separates the middle from the anterior lobe. The posterior lobe rests upon the tentorium.

The fissure of Sylvius lodges the middle cerebral artery. The *island of Reil* is the name given to some convolutions inclosed within the sides of the fissure. Another mode of description, now preferred by many anatomists, divides each cerebral hemisphere into *five* lobes: 1, anterior or frontal; 2, parietal; 3, temporal; 4, occipital; 5, central lobe, or island of Reil. The anterior or frontal lobe is separated from the parietal, by the *fissure of Rolando*, running obliquely outwards and forwards from near the middle line. The *internal perpendicular fissure* separates the parietal from the occipital lobe; and the latter is marked off below from the temporal lobe, by the *fissure of the hippocampus*. The central lobe, or island of Reil, is displayed (as above said) by opening out the fissure of Sylvius.

Laying the brain over to examine its basal surface, the order of location of parts is as follows: from before backwards, longitudinal fissure; on each side of this, bulb and trunk of *olfactory nerve; pituitary body*, resting upon the sella Turcica of the sphenoid bone; attached to the body, the *infundibulum;* connected with this, also, back of the *chiasm* or union of the optic nerves, the *tuber cinereum; corpora albicantia*, or eminentia mamillares; *crura cerebri; pons Varolii; medulla oblongata;* with the lobes of the *cerebellum* at its sides.

The *anterior perforated space*, or locus quadratus, is at the inner

Fig. 93.



Base of the Cerebrum and Cerebellum.—1. Fissure of the hemispheres. 2. Posterior extremity of the same fissure. 3. Anterior lobes of the cerebrum. 4 Its middle lobe. 5. Fissure of Sylvius. 6. Posterior lobe of the cerebrum. 7. Infundibulum. 8. Its body. 9. Corpora albicantia. 10. Cineritious matter. 11. Crura cerebri. 12. Pons Varolii. 13. Medulla oblongata. 14. Posterior prolongation of the pons Varolii. 15. Middle of the cerebellum. 16. Anterior part of the cerebellum. 17. Its posterior part and fissure. 18. Medulla spinalis. 19. Middle fissure of the medulla oblongata. 20. Corpus pyramidale. 21. Corpus restiforme. 22. Corpus olivare. 23. Olfactory nerve. 24. Its bulb. 25. Its external root. 26. Its middle root. 27. Its internal root. 28. Optic nerve beyond the chiasm. 29. Optic nerve before the chiasm. 30. Third pair of nerves. 31. Fourth pair. 32. Fifth pair. 33. Sixth pair. 34. Facial nerve. 35. Auditory. 36, 37, 38. Eighth pair of nerves.

end of the fissure of Sylvius, at the entrance of the branches of the olfactory nerve.

The *tuber cinereum* is a small prominence of gray nerve substance, between the optic commissure and the corpora albicantia; it forms part of the floor of the third ventricle.

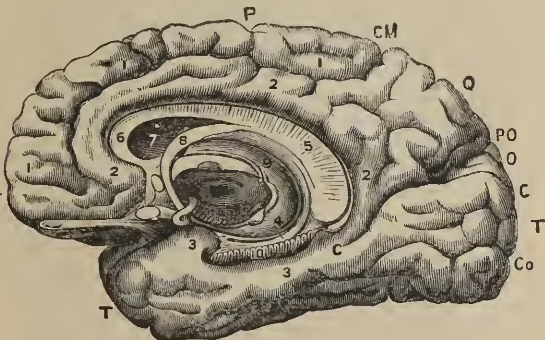
The *pituitary body* is a small reddish, vascular, oval mass; having two lobes; it is proportionally larger in the fœtus than in the adult. It has a cavity, leading through the infundibulum to the third ventricle. Its structure resembles that of the ductless glands.

The *corpora albicantia* are two small round bodies, of the size of peas, just back of the tuber cinereum.

The *pons Tarini* or *posterior perforated space* lies back of the corpora albicantia. Minute bloodvessels pass through it.

The *crura cerebri* are bundles of white nerve-substance diverging from the pons Varolii into the hemispheres, and widening as they pass forwards. In the interior of each crus is the dark gray *locus niger.* The third nerve (motor oculi) comes out from the crus; the fourth winds around it.

Fig. 94.



THE INNER AND UNDER SURFACES OF THE BRAIN, TO SHOW THE CONVOLUTIONS.—F. Frontal lobe. P. Parietal lobe. Q. Quadrate lobe. O. Occipital lobe. T, T. Temporal lobe. C, M. Calloso-marginal fissure. P, O. Parieto-occipital. C, C. Calcarine fissure. Co. Collateral fissure. 1, 1. Marginal convolution. 2, 2. Gyrus fornicatus. 3, 3. Uncinate gyrus. 4. Dentate convolution. 5. United corpus callosum and fornix. 6. Genu of corpus callosum. 7. Cavity of lateral ventricle. 8. Fornix. 9. Thalamus with corpora geniculata. 10. Fascia dentate in dentate fissure.

To examine the interior of the brain, it may be placed upon its base, and sliced away above the level of the *corpus callosum* or great transverse commissure joining the hemispheres. The mass of white substance, *centrum ovale*, is thus displayed. The corpus callosum is continuous behind the *fornix.* Removing or cutting through the corpus callosum, the *lateral ventricles* are exposed; with the *septum lucidum* for their thin dividing partition. The floor of each lateral ventricle is formed of the *corpus striatum*, *tænia semi-circularis*, *thalamus opticus*, *choroid plexus*, *corpus fimbriatum*, and *fornix.* Their roof is the corpus callosum.

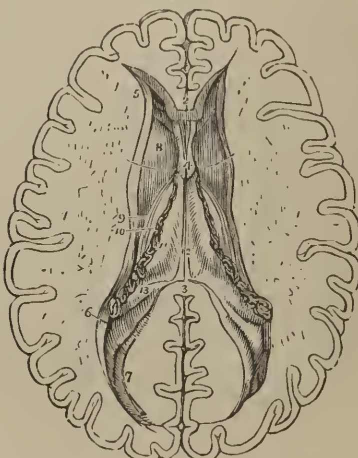
The *fornix* is a triangular plane of white nerve substance, of which the point is forwards. It is about the twelfth of an inch in thickness. It is supported by its anterior and posterior *crura* or curved pillars, which pass into the other parts of the brain. Its base, between the posterior crura, is continuous with the corpus callosum.

The *foramen of Monro* is a bifurcating opening or passage, from

the third ventricle below, upwards into the two lateral ventricles; just behind the anterior pillars of the fornix. The choroid plexus is prolonged through it.

The *septum lucidum*, between the two lateral ventricles, is formed of two laminæ or layers, between which is the cavity called the *fifth ventricle.*

Fig. 95.



LATERAL VENTRICLES OF THE CEREBRUM.—1, 1. The two hemispheres cut down. 2. A small portion of the corpus callosum. 3. Its posterior boundary. 4. Septum lucidum. 5. Anterior cornu. 6. Middle cornu. 7. Posterior cornu. 8. Corpus striatum. 9. Tænia striata. 10. Thalamus opticus. 11. Plexus choroides. 12. Fornix. 13. Hippocampus major.

The *cornua* of the lateral ventricles are the *anterior*, *middle*, and *posterior*. The *anterior* cornu is a curved triangular cavity passing outwards and forwards in the substance of the anterior lobe, in front of the corpus striatum.

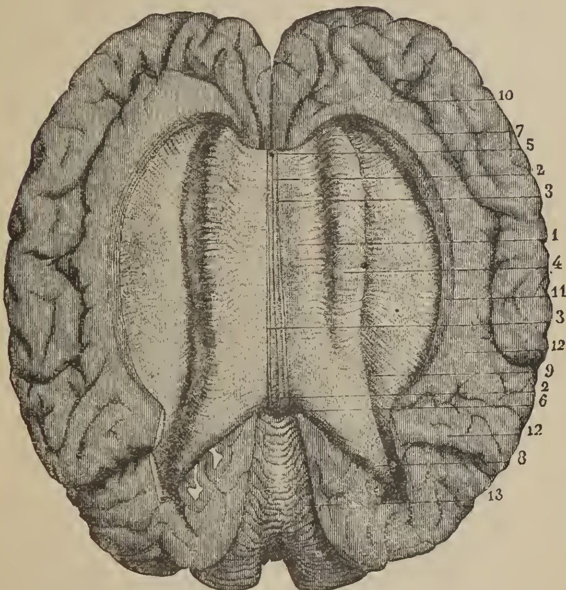
The *middle* cornu desends tortuously to terminate in the middle lobe. It contains within it the hippocampus major, pes hippocampi, pes accessorius, corpus fimbriatum, choroid plexus, fascia dentata, and transverse fissure.

The *hippocampus major*, or cornu ammonis, is a true convolution of the lateral edge of the hemisphere. The *corpus fimbriatum*, or tænia hippocampi, is a tape-like band of white nerve-substance attached to the inner border of the hippocampus. The *pes hippocampi* is a series of knotted elevations at the termination of the hippocampus major in front. *Pes accessorius* is behind the hippocampus major, between it and hippocampus minor.

The *fascia dentata*, or corpus denticulatum, is a narrow serrated layer of gray nerve-substance, displayed by raising the edge of the corpus fimbriatum. The *posterior cornu* curves into the posterior

lobe of the hemisphere. Its floor has a prominent cord-like elevation, the *hippocampus minor.*

Fig. 96.



View of the Corpus Callosum from above, ½.—The upper surface of the corpus callosum has been fully exposed by separating the cerebral hemispheres and throwing them to the side; the gyrus fornicatus has been detached, and the transverse fibres of the corpus callosum traced for some distance into the cerebral medullary substance. 1. The upper surface of the corpus callosum. 2. Median furrow or raphe. 3. Longitudinal striæ bounding the furrow. 4. Swelling formed by the transverse bands as they pass into the cerebrum. 5. Anterior extremity or knee of the corpus callosum. 6. Posterior extremity. 7. Anterior, and, 8 Posterior part of the mass of fibres proceeding from the corpus callosum. 9. Margin of the swelling. 10. Anterior part of the convolution of the corpus callosum. 11. Hem or band of union of this convolution. 12. Internal convolutions of the parietal lobe. 13. Upper surface of the cerebellum.

The *corpora striata* are two elongated pear-shaped masses, making parts of the floor of the lateral ventricles. Externally, they are of gray vesicular nerve-substance; within, they contain also a number of white medullary or tubular filaments. These are connected with the anterior or motor columns of the crura cerebri; and, through them, with the corpora pyramidalia of the medulla oblongata.

The *thalami* (*optici*) are rounded masses lying posterior to the corpora striata, and partly inclosed between them. They are composed externally of white nerve-substance, which, within, is blended and laminated with gray vesicular neurin. All the nerves of sensation are more or less directly connected with the thalami, or with the corpora olivaria of the medulla oblongata which are continuous with them.

The *tænia semicircularis* is a narrow cord of white nerve-substance, between the thalamus and the corpus striatum. Beneath it is a vein, the *vena Galeni*, which ends in the choroid plexus.

When the anterior crura of the fornix are divided and it is thrown backwards, a delicate membranous network is seen, which is the *velum interpositum*. Removing this, we expose under it the *third ventricle*. The velum interpositum is a continuation of the pia mater.

The *choroid plexus*, on each side, is the lateral margin of the velum interpositum; it consists of a red fringe of tortuous arteries and veins. The two choroid plexuses meet at the foramen of Monro.

The *third ventricle* is a narrow, oblong fissure, roofed by the fornix, floored by the posterior perforated space, corpora albicantia, tuber cinereum, and crura cerebri. It contains three transverse commissures, *anterior*, *middle*, and *posterior*. The middle is also called the *soft* commissure.

The *iter ad quartum ventriculum*, or aqueduct of Sylvius, is a canal from the posterior part of the third ventricle under the tubercula quadrigemina into the fourth ventricle.

The *iter ad infundibulum* is a canal from the anterior part of the third ventricle downwards into the infundibulum.

Behind the posterior commissure, are the small rounded bodies called *tubercula quadrigemina*, or *nates and testes*. The former are larger and anterior. They are connected with the optic thalamus by a bundle of white nerve-filaments also communicating with the cerebellum, called the *processus e cerebello ad testes*. The tubercula are thus between the cerebrum and cerebellum, and almost equally connected with both.

The *valve of Vieussens*, or valve of the brain, is a thin plane of white nerve-substance continuous with the lower margin of the testes, whence it extends as the roof of the fourth ventricle.

The *pineal gland* is a conical mass of gray nerve-substance, lying beneath the base of the fornix upon the nates of the tubercula quadrigemina. It is joined to the velum interpositum; and, by two *peduncles*, to the thalami and crura of the fornix. Without any reason, it has been imagined to be the special seat of the soul.

The *commissures* or connecting portions of the brain, composed of bands or bundles of white tubular nerve-filaments, are the *superior longitudinal*, above the corpus callosum within each hemisphere of the cerebrum, the *fornix* or *inferior longitudinal* commissure, the *corpus callosum*, and the *three transverse commissures* of the third ventricle.

The *pons Varolii* is the transverse commissure of the *cerebellum*. The valve of Vieussens and processus e cerebello ad testes make a *cerebro-cerebellar* connection or commissure.

Cerebellum.

The cerebellum is much smaller than the cerebrum, averaging in weight a little over five ounces in the adult. It is behind and below the cerebral hemispheres. It consists of a right and a left lateral hemisphere, divided from each other by a fissure; this being interrupted above by a ridge-like connection called the *median lobe* or *superior vermiform process;* and below, by the *inferior vermiform process.* A *horizontal fissure* also divides each hemisphere into an upper and a lower portion; and out of this fissure proceed several lesser ones.

Fig. 97.

VIEW OF CEREBELLUM IN SECTION AND OF FOURTH VENTRICLE, WITH THE NEIGHBORING PARTS.—1. Median groove of fourth ventricle, ending below in the *calamus scriptorius*, with the longitudinal eminences formed by the *fasciculi teretes*, one on each side. 2. The same groove, at the place where the white streaks of the auditory nerve emerge from it to cross the floor of the ventricle. 3. Inferior crus or peduncle of the cerebellum, formed by the restiform body. 4. Posterior pyramid; above this is the calamus scriptorius. 5. Superior crus of cerebellum, or processus a cerebello ad cerebrum (or ad testes). 6, 6. Fillet to the side of the crura cerebri. 7, 7. Lateral grooves of the crura cerebri. 8. Corpora quadrigemina.

The outer portion of the cerebellum consists of a large number of delicate layers or *lamellæ*, laid one upon another. Making a vertical *section* of it, we see a tree-like arrangement within, called the *arbor vitæ;* consisting of white nerve substance inclosed in vesicular neurin. In the trunk of the arbor vitæ is an irregular mass of vesicular nerve-substance, the *corpus dentatum.* The proportion of gray nerve-matter is large in the cerebellum, making the whole of its exterior lamellar surface. The pia mater dips in between its layers.

The name of *peduncles* of the cerebellum is sometimes given to—1, the *processus e cerebello ad testes*, previously described; 2, the *crura cerebelli*; 3, the *corpora restiformia*, extending to the medulla oblongata. The crura cerebelli radiate from the pons Varolii (great transverse commissure of the cerebellum) into all parts of the cerebellum.

The *fourth ventricle* is a cavity between the medulla oblongata in front and the cerebellum behind. It is somewhat triangular, narrowest above. Its floor is the medulla oblongata and pons Varolii; its roof, the valve of Vieussens and tubercula quadrigemina. It communicates with the third ventricle by the *iter e tertio ad quartum ventriculum*, or aqueduct of Sylvius. The longitudinal fissure in the floor of the fourth ventricle presents a pen-like form, called the *calamus scriptorius*.

The *pons Varolii*, or *tuber annulare*, already named, is a rounded mass of about an inch in diameter, resting by its convex surface upon the *clivis* or junction of the occiput and sphenoid bone. It is composed of white tubular filaments, nearly all transverse, blended with gray vesicular nerve-substance. The transverse fibres connect the hemispheres of the cerebellum. The longitudinal filaments are continuous with the corpora pyramidalia of the medulla oblongata behind, and, in front, with the crura cerebri.

Medulla Oblongata.

Being the connecting portion between the spinal cord and the brain, the lower and posterior boundary of the medulla oblongata is the foramen magnum occipitis. Its form is pyramidal; its length, to the pons Varolii, about an inch and a quarter.

Besides an anterior and a posterior longitudinal fissure, continuous with the fissures of the spinal cord, it is, by other *sulci* or furrows, subdivided into four portions; the *corpora pyramidalia*, *corpora olivaria*, *corpora restiformia*, and *posterior ganglia*.

The *corpora pyramidalia* are anterior. They consist of bundles of white tubular nerve-substance. A *decussation* or crossing over of a fasciculus of each pyramid occurs about three-fourths of an inch below the pons. Above, after penetrating the pons, the corpora pyramidalia expand, and, passing on through or forming part of the crura cerebri, diverge to form a large part of the cerebral hemispheres.

The *corpora olivaria* are two elliptical bodies, external to the pyramidalia. They are composed of a mixture of white and gray nerve-substance; having a covering of the white, then a mass of gray vesicular material (corpus dentatum), and within this a central white portion. They send fibres to the tubercula quadrigemina and thalami.

The *corpora restiformia* are the posterior and lateral rope-like prolongations of the antero-lateral and posterior columns of the spinal cord. Above, they pass into the cerebellum, as the crura cerebelli.

The *posterior ganglia* or *posterior pyramids* are smaller, and lie next to the posterior fissure. They are entirely of white nerve-substance, continuous with the posterior tracts of the spinal cord.

Fig. 98.

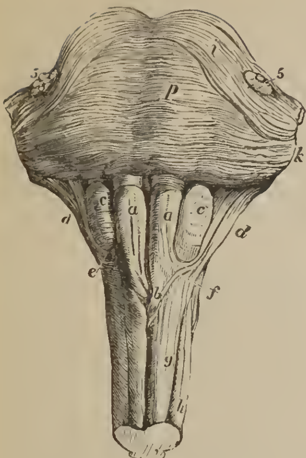
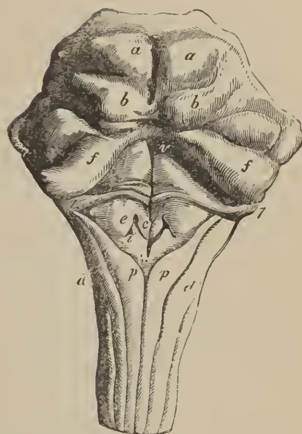


Fig. 99.



View of the Anterior Surface of the Pons Varolii, and Medulla Oblongata.—*a*, *a*. Anterior pyramids. *b*. Their decussation. *c*, *c*. Olivary bodies. *d*, *d*. Restiform bodies. *e*. Arciform fibres. *f*. Fibres described by Solly as passing from the anterior column of the cord to the cerebellum. *g*. Anterior column of the spinal cord. *h*. Lateral column. *p*. Pons Varolii. *i*. Its upper fibres. 5, 5. Roots of the fifth pair of nerves.

View of the Posterior Surface of the Pons Varolii, Corpora Quadrigemina, and Medulla Oblongata. The peduncles of the cerebellum are cut short at the side.—*a*, *a*. The upper pair of corpora quadrigemina. *b*, *b*. The lower. *f*, *f*. Superior peduncles of the cerebellum. *c*. Eminence connected with the nucleus of the hypoglossal nerve. *e*. That of the glosso-pharyngeal nerve. *i*. That of the vagus nerve. *d*, *d*. Restiform bodies. *p*, *p*. Posterior pyramids. *v*, *v*. Groove in the middle of the fourth ventricle, ending below in the calamus scriptorius. 7, 7. Roots of the auditory nerves.

SPINAL CORD.

The *length* of the spinal cord from the foramen magnum occipitis to the *cauda equina* in the lumbar region, averages about eighteen inches. Its *width* is greatest in the upper cervical region ; less in the middle dorsal ; enlarged again in the lower dorsal ; and thence diminishing gradually to a conical point opposite the second lumbar vertebra.

Spinal Membranes.

These are continuous with the *dura mater*, *arachnoid*, and *pia mater* of the brain. Adhering to the first cervical vertebra, the *spinal dura mater* is loose in the vertebral canal down to an at-

tachment to the *os coccygis*. It invests, by processes, each of the spinal nerves to the intervertebral foramen, and surrounds the ganglion on the posterior root of each.

The *spinal arachnoid* contains, between it and the pia mater, the *cerebro-spinal* fluid; communicating with the subarachnoid space of the brain.

The *spinal pia mater* is more dense and fibrous, and less vascular, than the pia mater of the brain. Between it and the arachnoid, on each side of the cord, is a narrow band called the *denticulate ligament*. This, being attached to the dura mater by fifteen or twenty processes, detains the membranes in their position in relation to the cord.

Fissures of the Cord.

The *anterior* fissure is the widest, but extends only to one-third of the diameter of the spinal marrow. At its bottom is a thin layer of white nerve-substance, the *anterior commissure*.

The *posterior* fissure is deeper. At its bottom is a layer of gray nerve-substance. Both are lined by the pia mater.

On each side is a *lateral* fissure; somewhat back of the middle of the cord. This does not run the whole length of the cord. Anterior to this, and posterior to it, on each side, are lesser fissures, the *antero-lateral* and *postero-lateral sulci;* corresponding with the anterior and posterior roots of the spinal nerves.

Columns.

Each half of the cord may be described as consisting of two columns; *antero-lateral* and *posterior* or *postero-lateral* column. The antero-lateral is much the larger; but the difference is greatest in the cervical region, and least in the lumbar.

Structure of the Cord.

A transverse section shows the gray vesicular nerve-substance to be inclosed within the white medullary portion. The gray substance presents, in section, the form of two crescents, connected by a commissure. The white columns are also joined by the anterior commissure. The white substance is composed chiefly of longitudinal laminæ of tubular filaments, in contact by their inner portion with the gray matter of the cord.

Origin of the Spinal Nerves.

There are, of these nerves, thirty-one pairs; eight cervical, twelve dorsal, five lumbar, and six sacral nerves, for each side. Each nerve has its *anterior* and *posterior roots*. The *anterior* roots arise from the antero-lateral column, and emerge through the anterior lateral sulcus. The *posterior* roots enter the postero-lateral sulcus, to connect with the posterior column.

All, or nearly all, the fibres of both roots proceed through the white columns into the gray substance. Those of both *decussate* freely from side to side, and also pass upwards and downwards, as well as diverge in all directions. The complete history of their termination and connections remains yet to be finally traced.

CRANIAL OR CEPHALIC NERVES.

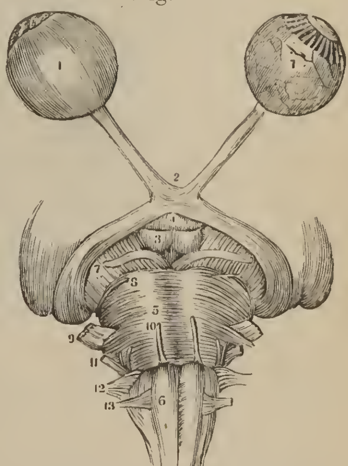
Though not in all respects a satisfactory arrangement, these are usually described as nine pairs: 1st, olfactory; 2d, optic; 3d, motor oculi; 4th, pathetic; 5th, trifacial; 6th, abducens oculi; 7th, facial or portio dura, and auditory or portio mollis; 8th, glosso-pharyngeal, pneumogastric, and spinal accessory; 9th, hypoglossal.

Olfactory nerve.—Arising (to use the common language of anatomists) by three roots, from the anterior and middle parts of the base of the cerebrum, the first nerve proceeds forward as a flat band upon the under surface of the anterior lobe, not far from the longitudinal fissure. On the ethmoid bone, it expands into the *olfactory bulb;* from which pass, through the *cribriform plate* of the ethmoid, about twenty filaments, to be distributed to the mucous (Schneiderian) membrane of the nostril.

The olfactory nerve-trunk is soft, and contains gray matter in its interior.

Optic nerve.—The second nerve of each side unites with its fellow at the *optic chiasm* or commissure, within the skull, in front of the tuber cinereum. There a partial decussation occurs. Some fibres cross from the retina of one eyeball to that of the other; some from one side of the brain to the other; some from the eye on one side to the brain on the other; and some from each eye to the same side of the base of the brain.

Fig. 100.



THE SECOND PAIR, OR OPTIC NERVES.—1, 1. Globe of the eye. 2. Chiasm of the optic nerves. 3. Corpora albicantia. 4. Infundibulum. 5. Pons Varolii. 6. Medulla oblongata. 7. Third pair. 8. Fourth pair. 9. Fifth pair. 10. Sixth pair. 11. Seventh pair. 12. Eighth pair. 13. Ninth pair.

Back of the commissure, the *optic tract* divides on each side into two bands, which continue to the *thalami*, the *corpora geniculata*, and the *tubercula quadrigemina.*

Anteriorly, the optic nerve of each side emerges by the optic foramen of the sphenoid bone, pierces the sclerotic and choroid coats of the eyeball a little to the nasal side of its centre, and is distributed to the retina. The *arteria centralis retinæ* perforates it, with corresponding veins.

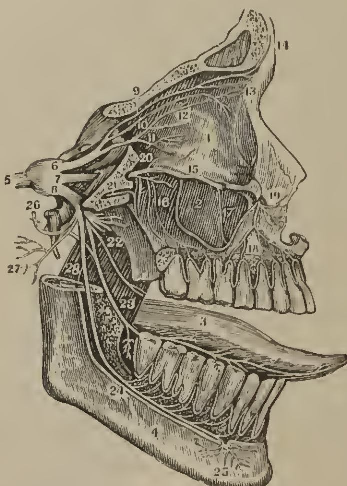
Motor oculi.—The third nerve originates in the crus cerebri in front of the pons Varolii. After receiving a few filaments from the cavernous plexus of the sympathetic, it divides into two branches which enter the orbit through the sphe-

noidal fissure. It is finally distributed to all the muscles of the eyeball.

Pathetic nerve.—The fourth, sometimes called trochlear nerve, arises from the valve of Vieussens behind the tubercula quadrigemina. Winding around the crus cerebri, it passes into the orbit through the sphenoid fissure. It supplies only the superior oblique muscle of the eye.

Trifacial or fifth pair.—This, the largest of the cephalic nerves, arises, like the spinal nerves, by two roots; the posterior of which has a ganglion upon it. Both roots are connected with the medulla oblongata, through the pons Varolii. Near the apex of the petrous portion of the temporal bone, the posterior and larger

Fig. 101.



DISTRIBUTION OF THE FIFTH PAIR.—1. Orbit. 2. Antrum Highmorianum. 3. Tongue. 4. Lower jaw-bone. 5. Root of the fifth pair forming the ganglion of Gasser. 6. First branch of the fifth pair. 7. Second branch. 8. Third branch. 9. Frontal branch. 10. Lachrymal branch. 11. Nasal branch. 12. Internal nasal nerve. 13. External nasal nerve. 14. External and internal frontal nerve. 15. Infra-orbital nerve. 16. Posterior dental branches. 17. Middle dental branch. 18. Anterior dental nerve. 19. Terminating branches of the infra-orbital nerve. 20. Orbitar branch. 21. Pterygoid, or recurrent nerve. 22. Five anterior branches. 23. Lingual branch of the fifth. 24. Inferior dental nerve. 25. Its mental branches. 26. Superficial temporal nerve. 27. Auricular branches. 28. Mylo-hyoid branch.

root enters the *Casserian (semilunar) ganglion.* From this go off two great branches of the nerve, the *ophthalmic* and *superior maxillary;* which are therefore sensory nerves only. Below it, with fibres from both roots, passes the *inferior maxillary*, which has

sensory and motor filaments. The ophthalmic, or first branch of the fifth, goes out through the sphenoidal fissure; the second or superior maxillary, through the foramen rotundum of the sphenoid bone; the third, inferior maxillary, through the foramen ovale of the same bone.

Ophthalmic nerve.—The subdivisions of this are, the *lachrymal*, *frontal*, and *nasal* nerves. The *lachrymal* is smallest. It goes to the lachrymal gland, conjunctiva, and tegument of the upper eyelid.

The *frontal* is larger. It divides into the *supra-trochlear* and *supra-orbital* branches. The first is distributed to the corrugator supercilii and occipito-frontalis muscles and the tegument of the forehead. The supra-orbital passes through the supra-orbital foramen, giving off filaments to the upper eyelid; then terminating in muscular, cutaneous, and pericranial branches, for the forehead and brow.

The *nasal* nerve leaves the orbit by the anterior ethmoidal foramen, enters the cavity of the cranium, goes over the cribriform plate of the ethmoid to the side of the crista galli, and there descends into the nose. Then it divides into the *external* and *internal* branches. The internal supplies the mucous membrane of the nostril, the external goes beneath the end of the nasal bone to be distributed with the facial nerve to the skin of the wing and tip of the nose.

Before this division, the nasal nerve gives off the *ganglionic*, two *long ciliary*, and *infra-trochlear* branches. The ganglionic enters the ciliary ganglion. The long ciliary go to the ciliary muscle and iris, with the short ciliary nerves from the ganglion. The infra-trochlear goes to the parts about the inner angle of the eye.

Superior maxillary nerve.—Its subdivisions are, 1. In the spheno-maxillary fossa: *orbital*, *spheno-palatine*, *posterior dental*. 2. In the infra-orbital canal: *anterior dental*. 3. On the face: *palpebral*, *nasal*, *labial*.

The *orbital* branch splits into the *temporal* and *malar*. The former passes through the malar bone into the temporal muscle and integument. The malar goes through a foramen in the malar bone to join the facial. The two spheno-palatine branches go to the ganglion of the same name. The posterior dental branches form a plexus with the anterior dental, from which filaments go to the molar and bicuspid teeth; supplying also the gums and buccinator muscle.

The *anterior dental* nerve enters a canal in the front wall of the antrum, and joins with the posterior dental. It sends fibres to the incisor, canine, and bicuspid teeth; some, also, to the tegument.

The *palpebral* branches go to the muscle, conjunctiva, and tegument of the lower eyelid.

The *nasal* branches supply the side of the nose, joining with filaments of the ophthalmic.

The *labial* branches are distributed to the skin and muscles of the upper lip and the mucous membrane of the mouth.

All these branches contribute, with some from the facial nerve, to make the *infra-orbital plexus* just below the orbit.

Inferior maxillary nerve.—After its exit from the foramen ovale,

this nerve divides into a *smaller anterior* and a *larger posterior* trunk. The former gives off *masseteric, deep temporal, buccal,* and *pterygoid* branches, to the muscles of mastication. The *larger posterior* portion divides into the *auriculo-temporal, gustatory,* and *inferior dental* nerves.

Fig. 102.

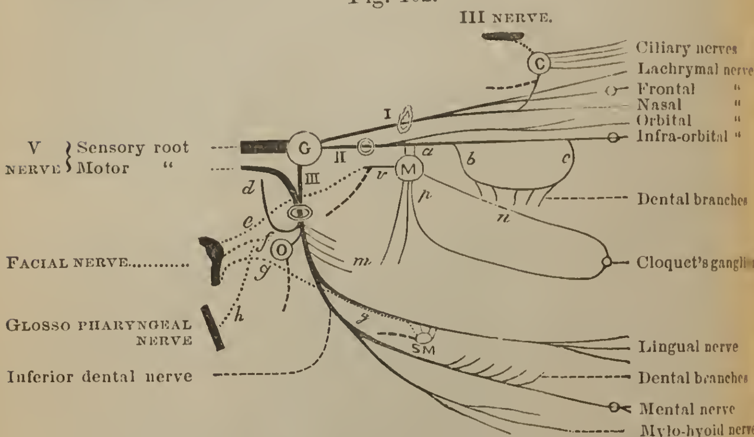


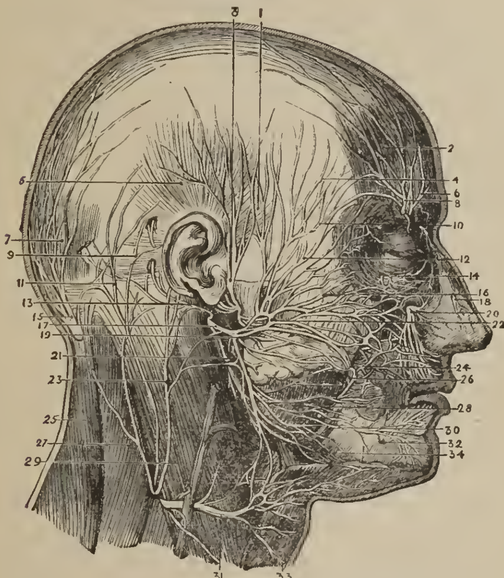
DIAGRAM OF THE FIFTH NERVE AND ITS GANGLIA.– G. Ganglion of Gasser. C. Ciliary ganglion. M. Meckel's ganglion. O. Otic ganglion. S M. Submaxillary ganglion. I. First or ophthalmic division of fifth passing through the sphenoidal fissure. II. Second or superior maxillary division of fifth passing through the foramen rotundum III. Third or inferior maxillary division of fifth (containing all the motor root) passing through the foramen ovale. . . . . . . Motor roots of the ganglia. ——— Sensory roots of the ganglia. ----- Sympathetic roots of the ganglia. *a.* Spheno-palatine nerves. *b.* Posterior dental nerve. *c.* Anterior dental nerve. *d.* Auriculo-temporal nerve. *e.* Greater (or large) superficial petrosal nerve, which, after it is joined by the sympathetic branch from the carotid plexus, becomes the Vidian (*v*) and goes to the ganglion of Meckel (M). *f.* Lesser (or small) superficial petrosal going to the otic ganglion (O). *g, g.* Chorda tympani nerve going to join the inferior dental and thence to the submaxillary ganglion (S M). *h.* Branch of Jacobson's nerve (glosso-pharyngeal) which joins the lesser superficial petrosal nerve. *m.* Muscular branches to muscles of mastication. *n.* Naso-palatine nerve. *p.* Palatine nerves, the anterior anastomosing with the naso-palatine. *v.* Vidian nerve. The three foramina of exit of the fifth nerve on the face are indicated by small circles on the frontal, infra-orbital, and mental nerves.

The *auriculo-temporal* goes to join the temporal artery near the articulation of the lower jaw; thence upwards under the parotid gland, above which it divides into the anterior and posterior temporal branches. It has, first, the two *auricular,* the *articular* branches, two branches to the *meatus auditorius,* and *parotid* branches.

The *gustatory* or *lingual* nerve is deeply placed, and supplies the

mucous membrane and papillæ of the tongue, anastomosing at the tip of the latter with the terminations of the hypoglossal nerve.

Fig. 103.



NERVES OF THE FACE AND SCALP.—1. Attrahens aurem muscle. 2. Anterior belly of occipito-frontalis. 3. Auriculo-temporal nerve. 4. Temporal branches of facial nerve (7th). 5. Attollens aurem muscle. 6. Supra-trochlear nerve (5th). 7. Posterior belly of occipito-frontalis. 8. Supra-orbital nerve (5th). 9. Retrahens aurem muscle. 10. Temporal branch of orbital nerve (5th). 11. Small occipital nerve. 12. Malar branches of facial nerve. 13. Posterior auricular nerve (7th). 14. Malar branch of orbital nerve (5th) (subcutaneus malæ). 15. Great occipital nerve. 16. Infra-orbital branches of facial nerve (7th). 17. Facial nerve (7th). 18. Nasal nerve (5th). 19. Cervico-facial division of 7th. 20. Infra-orbital nerve (5th). 21. Branches to digastric and stylo-hyoid (7th). 22. Temporo-facial division of 7th. 23. Great auricular nerve. 24. Buccal branches of facial nerve. 25. Trapezius. 26. Buccinator [long buccal] nerve (5th). 27. Splenius captis. 28. Masseter. 29. Sterno-mastoideus. 30. Supra-maxillary branches of facial nerve (7th). 31. Superficial cervical nerve. 32. Mental nerve (5th). 33. Platysma 34. Infra-maxillary branches of facial nerve (7th).

The *inferior dental* nerve goes down with the inferior dental artery to the dental foramen. Then, in the dental canal, beneath the teeth of the lower jaw, it passes forwards to the mental foramen; where it divides into the *incisor* and *mental* branches. The former supplies the incisor and canine tooth-pulps. The latter goes out at the mental foramen, and supplies the muscles, mucous

membrane, and tegument of the lower lip. The inferior dental gives off, before this, the *mylo-hyoid* and *dental* branches. The *latter* go to the pulps of the molar and bicuspid teeth.

Ganglia connected with the fifth nerve.—These are: 1. The *ophthalmic*, *lenticular*, or *ciliary* ganglion; 2. *Spheno-palatine* ganglion; 3. *Otic* ganglion (of Arnold); 4. *Submaxillary* ganglion. Belonging to the sympathetic system, these will all be described in connection with it.

Abducens or sixth pair.—This nerve originates from the medulla oblongata, close to the pons Varolii. It enters the orbit of the eye through the sphenoidal fissure, and is distributed to the external rectus muscle of the eyeball.

Facial nerve.—This, the *portio dura* of the seventh pair, arises from the medulla oblongata, passes upon the crus cerebelli, and enters the internal auditory meatus with the *portio mollis* or auditory nerve. At the bottom of the meatus, it goes into and through the aqueduct of Fallopius of the petrous portion of the temporal bone. Then, emerging from the stylo-mastoid foramen, it runs forward in the parotid gland, crossing the external carotid artery, to divide behind the ramus of the lower jaw into two primary branches, the *temporo-facial* and *cervico-facial.*

Within the aqueduct of Fallopius, this nerve gives off the *tympanic nerve* and the *chorda tympani.* At its exit from the stylo-mastoid foramen, the *posterior auricular*, *digastric*, and *stylo-hyoid.* The temporo-facial branch divides into the *temporal*, *malar*, and *infra-orbital nerves.* The cervico-facial, into the *buccal*, *supra-maxillary*, and *infra-maxillary.*

The *tympanic* branch supplies the stapedius and laxator tympani muscles.

The *chorda tympani* ascends in a canal parallel to the aqueduct of Fallopius, passes into and through the cavity of the tympanum, emerges from it near the Glaserian fissure, descends to meet the gustatory nerve, goes with it through the submaxillary gland, and terminates in the lingualis muscle.

The *posterior auricular* divides into the *auricular* and *occipital* branches; the latter being the larger.

The *stylo-hyoid* goes to the muscle of that name.

The *digastric* supplies the digastricus muscle; a filament goes through this to join the glosso-pharyngeal nerve.

Of the *temporo-facial* division of the seventh, the *temporal* branches join with branches of the fifth pair to supply the occipito-frontalis and orbicularis oculi muscles.

The *malar* branches supply the orbicularis oculi and corrugator supercilii muscle.

The *infra-orbital* branches are distributed, some deeply and others superficially, between the lower margin of the orbit and the mouth.

The *cervico-facial* division of the facial nerve sends *buccal* branches to the buccinator and orbicularis oris; *supra-maxillary* branches to the lower lip and chin; and *infra-maxillary* branches, of which some join the superficial cervical nerve from the cervical plexus, and others supply the platysma myoides and levator labii inferioris muscles.

The *auditory* nerve, *portio mollis*, of the seventh pair, enters the meatus auditorius internus, and is distributed to all parts of the labyrinth or internal ear.

Eighth pair.—This is a threefold nerve, composed of the *glosso-pharyngeal*, *pneumogastric*, and *spinal accessory*.

Glosso-pharyngeal.—The origin of this is from the upper part of the medulla oblongata. Leaving the skull by the jugular foramen, it descends in front of the internal carotid artery, and arches on the side of the neck, to be finally distributed to the mucous membrane of the fauces, tonsils, and base of the tongue. While in the jugular foramen, this nerve has two enlargements, the *jugular* and *petrous* ganglia. The glosso-pharyngeal communicates by filaments with the pneumogastric, facial, and sympathetic nerves. A *tympanic* branch (nerve of Jacobson) goes off from the petrous ganglion, penetrates a canal of the temporal bone, enters the tympanum, and is there distributed, after dividing into three branches.

The divisions of the glosso-pharyngeal nerve are, the *carotid*, *pharyngeal*, *muscular*, *tonsillitic*, and *lingual*.

The *carotid* branches descend along the trunk of the internal carotid artery.

The *pharyngeal* branches form the pharyngeal plexus with filaments of the pneumogastric, superior laryngeal, and sympathetic nerves. From this plexus nerves pass through the muscular coat of the pharynx to supply the mucous membrane.

The *muscular* branches go principally to the stylo-pharyngeus muscle.

The *tonsillitic* branches form a sort of plexus around the tonsil.

The *lingual* branches are two. One goes to the base and the other to the side of the tongue. These are nerves of taste.

Pneumogastric or par vagum.—This part of the eighth pair arises from the medulla oblongata, and emerges from the cranium through the jugular foramen in the same sheath with the spinal accessory. In this foramen it presents an enlargement called, sometimes, the *ganglion of the root* of the pneumogastric. Lower, it has the *inferior ganglion*, or ganglion of the trunk. It then descends within the sheath of the carotid; but has a different course on the two sides of the body. On the right side, it crosses the subclavian artery and goes down beside the trachea to the root of the lung, where it forms a sort of plexus. From this two branches go to the œsophagus, making with those of the other side the œsophageal plexus. These branches unite below into a nerve which runs down back of the œsophagus to be distributed upon the posterior surface of the stomach.

On the left side, the pneumogastric passes between the carotid and subclavian arteries, crosses the arch of the aorta, and descends behind the root of the lung and in front of the œsophagus, finally distributing branches over the anterior surface and lesser curvature of the stomach.

The *branches* of the pneumogastric are the *auricular*, *pharyngeal*, *superior laryngeal*, *recurrent laryngeal*, *cervical cardiac*, *thoracic cardiac*, *anterior* and *posterior pulmonary*, *œsophageal*, and *gastric* branches.

The *auricular* goes from the ganglion of the root, through the temporal bone, to the back of the ear.

The *pharyngeal* arises from the inferior ganglion, and is distributed to the muscles and mucous membrane of the pharynx; some filaments terminating, with some from the glosso-pharyngeal, upon the internal carotid artery.

The *superior laryngeal* goes from the inferior ganglion down by the side of the pharynx, and divides into the *external* and *internal laryngeal*. The external branch supplies the thyroid gland and crico-thyroid muscle. The internal passes to the mucous membrane of the larynx, and crico-arytenoid muscle. It communicates with the recurrent laryngeal.

The *inferior* or *recurrent laryngeal* winds around the subclavian artery on the right side, around the aorta on the left, ascends between the trachea and œsophagus, and is by its branches distributed to the muscles of the larynx, except the crico-thyroid. Cardiac, œsophageal, tracheal, and pharyngeal filaments go from it. Its motor function is probably due to filaments from the spinal accessory.

The *cervical cardiac* branches are two or three, which go to the great cardiac plexus, or to the cardiac branches of the sympathetic.

The *thoracic cardiac* branches arise lower, and have a similar distribution.

The *anterior pulmonary* branches are two or three small fasciculi, which join with sympathetic fibres, to make the anterior pulmonary plexus.

The *posterior pulmonary* are larger and more numerous; they form the posterior pulmonary plexus by union with filaments of the sympathetic. Both of these sets of ramifications attend the air-tubes in their distribution into the lungs.

The *œsophageal* and *gastric* branches have been already sufficiently described.

Spinal accessory.—This may be said to have two parts; the *spinal* portion and the portion *accessory* to the pneumogastric. The *spinal* part arises from the side of the spinal marrow, as low as the sixth cervical nerve, enters the cranium by the foramen magnum occipitis, again passes out by the jugular foramen, being there connected with the accessory portion; then, going behind the internal jugular vein, it descends obliquely behind the digastric and stylo-hyoid muscles to the sterno-cleido-mastoid muscles; finally, terminating in the trapezius muscle.

The *accessory* portion is smaller. It arises not far below the origin of the pneumogastric, in the medulla oblongata; goes out through the jugular foramen, communicating there with the par vagum, whose pharyngeal and superior laryngeal branches it accompanies in their distribution.

Hypoglossal nerve.—The ninth nerve of anatomists, more truly the twelfth of the series, originates in the medulla oblongata, and passes out through the anterior condyloid foramen of the occiput. Descending the neck, it winds around the occipital artery, crosses the external carotid, runs between the mylo-hyoid and hyoglossus muscles, to distribute branches to the whole of the tongue.

Its main branches are, the *descendens noni*, *thyro-hyoid*, and *muscular*.

The *descendens noni* is a slender branch, which goes across the sheath of the carotid vessels, making a loop with branches from the second and third cervical nerves. It sends thence filaments to the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles; perhaps, also, to the phrenic and cardiac nerves.

The *thyro-hyoid* goes to the muscle of that name. The *muscular* branches supply the stylo-glossus, hyo-glossus, genio-hyoid, and genio-hyo-glossus muscles.

Functions of Cephalic Nerves.—So far as is yet ascertained, the following (from Gray) is a correct statement:—

Nerves of Special Sense.	Nerves of Motion.
Olfactory (1st),	Motor oculi (3d),
Optic (2d),	Patheticus (4th),
Auditory (portio mollis of 7th),	Part of third branch of 5th,
Part of glosso-pharyngeal (of taste),	Abducens oculi (6th),
Lingual branch of 5th (of taste).	Facial (portio dura of 7th),
	Hypoglossal (9th).

Nerves of Common Sensation.	Mixed Nerves.
Greater portion of 5th,	Pneumogastric (part of 8th),
Part of glosso-pharyngeal (of 8th).	Spinal accessory (of 8th).

SPINAL NERVES.

Of these the roots have been described already, in their connection with the spinal marrow. Upon each *posterior* root, in the intervertebral foramen, outside of the dura mater, there is a *ganglion;* just beyond this, the two roots unite into one trunk, which soon again subdivides into *anterior* and *posterior* branches; each of which is furnished with filaments from both roots. The anterior branches are usually largest.

Eight Cervical Nerves.

The *first* leaves the spinal canal between the atlas and the occiput. It is called the *sub-occipital* nerve. It divides, as do *all* the spinal nerves, into anterior and posterior branches. The former joins the second cervical nerve. The latter goes to the recti and obliqui capitis and complexus muscles.

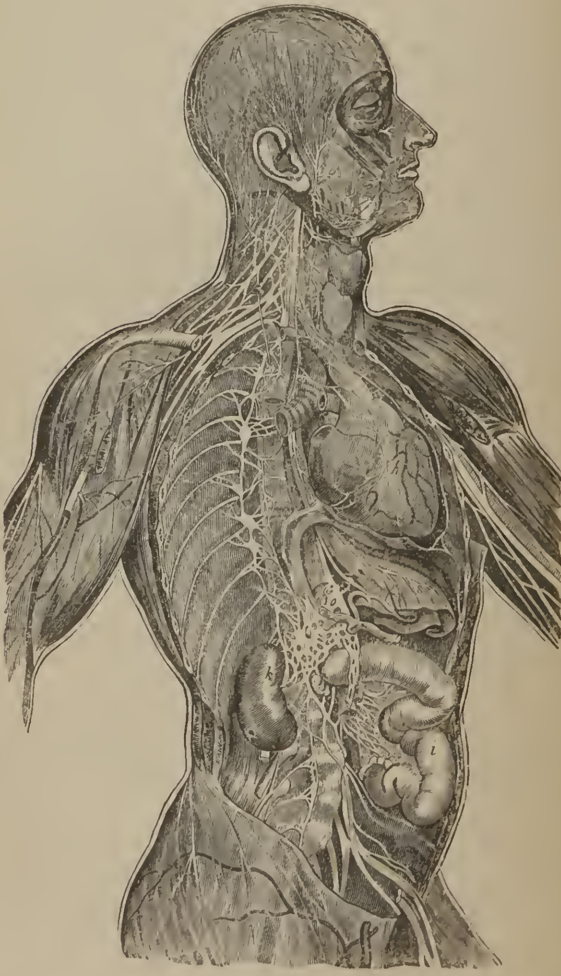
The *second* goes out between the atlas and the axis or second vertebra. Its anterior branch sends one fasciculus up to join the first nerve, and two down to connect with the third. Its posterior branch is larger, and goes to muscles of the back of the neck.

The anterior branch of the *third* is twice as large as that of the second; and so is the anterior branch of the fourth. Besides communicating with several other nerves, they unite at the cervical plexus. Their posterior branches go to the trapezius and other neighboring muscles and the integument.

Cervical plexus.—This is formed by the anterior branches of the first four cervical nerves. It lies in front of the first four vertebræ.

Its branches are *superficial and deep.* Of the first, there are the *ascending* ones, viz., *superficialis colli, auricularis magnus,* and

Fig. 104.



THE NERVES.

occipitalis minor; and *descending,* the *supra-clavicular,* subdividing into the *sternal, clavicular,* and *acromial* nerves. Deep branches of this plexus are, the *internal* ones, viz., the *communicating, mus-*

cular, *communicans noni*, and *phrenic* nerves; and *external*, the *communicating* and *muscular* nerves. These are distributed to the muscles and integument of the back of the head, and of the neck and chest. The *phrenic* nerve requires special description. Arising from the third and fourth cervical nerves, with a communicating branch from the fifth, it descends to the root of the neck, lying across the scalenus anticus muscle, passes between the subclavian artery and vein, and crosses the internal mammary artery as it enters the chest. The *right* phrenic nerve is shortest. It lies outside of the right vena innominata and the descending vena cava. The *left* phrenic crosses in front of the arch of the aorta to the root of the lung. Both are distributed to the diaphragm; sending filaments also to the pleura and pericardium. The right nerve communicates with the phrenic branches of the solar plexus; the left, with the phrenic plexus.

The Brachial Plexus.

Brachial plexus.—The anterior branches of the four cervical and the first dorsal nerves unite to form this. It extends from the lower portion of the neck to the axilla, and is quite wide. It communicates with the cervical plexus by a branch from the fourth to the fifth nerve. Its branches are—1. Above the clavicle: *communicating*, *muscular*, *posterior thoracic*, and *supra-scapular*. 2. Below the clavicle: to the chest, *anterior thoracic;* to the shoulder, *subscapular*, and *circumflex;* to the arm, forearm, and hand, *musculo-cutaneous*, *internal cutaneous*, *lesser internal cutaneous*, *median*, *ulnar*, and *musculo-spiral*.

The *communicating* goes to the phrenic. The *muscular* branches go to the scaleni, longus colli, rhomboideus, and subclavius muscles.

The *posterior thoracic* is a long branch, going through the scalenus medius muscle down to the bottom of the serratus magnus, to which it is distributed.

The *supra-scapular* nerve goes beneath the trapezius muscle to pass through a notch in the upper border of the scapula, to supply the supra-spinatus and infra-spinatus muscles.

The *anterior thoracic* nerves are two, the *external* or superficial, and the *internal* or deep branch. They are distributed to the pectoralis muscles.

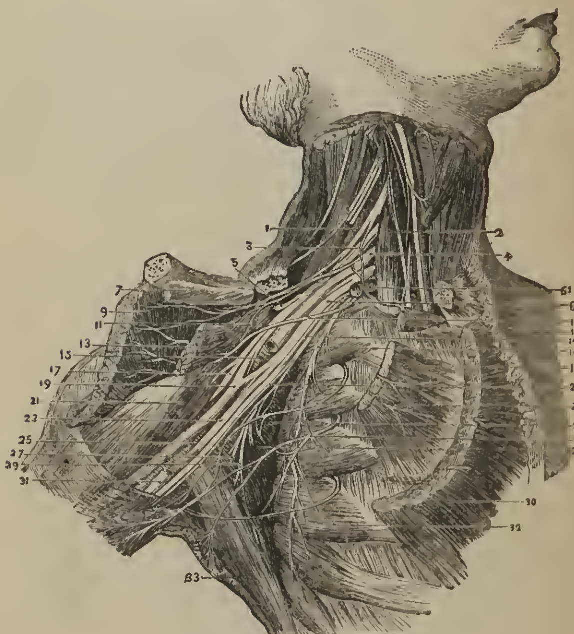
The *subscapular* nerves are three; they supply the subscapularis, teres major, and latissimus dorsi muscles.

The *circumflex* nerve goes down behind the axillary artery, and, below the subscapularis muscle, divides into the *upper* and *lower* branches. The upper winds around the neck of the humerus with the circumflex bloodvessels; supplying the deltoid muscle and the integument over it. The lower is distributed to the teres minor, deltoid, and triceps muscles, and integument over the last two.

The *musculo-cutaneous* nerve perforates the coraco-brachialis muscle, passes between the biceps and brachialis anticus, and, after sending off muscular filaments, becomes cutaneous on the outer side of the arm above the elbow; near the elbow-joint it subdivides into an *anterior* and a *posterior* branch. The anterior descends along the radial margin of the forearm, gets in front of

the radial artery at the wrist, and goes with it to the back of the wrist. It receives a branch from the radial nerve. The posterior branch goes down back of the outer side of the forearm, to supply

Fig. 105.



THE NERVES OF THE AXILLA.—1. Scalenus medius. 2. Scalenus anticus. 3. Cord formed by 5th and 6th cervical nerves. 4. 7th cervical nerve. 5. Suprascapular nerve. 6. Subclavian artery (cut). 7. Insertion of subclavius. 8. Cord formed by 8th cervical and 1st dorsal nerves. 9. Pectoralis major (reflected). 10. Internal anterior thoracic nerve. 11. External anterior thoracic nerve. 12. Origin of subclavius. 13. Pectoralis minor (reflected). 14. Internal cutaneous nerve. 15. Axillary artery (cut). 16. Posterior thoracic nerve (Bell.) 17. Musculo-cutaneous nerve. 18. Origin of pectoralis minor. 19. Median nerve. 20. Nerve of Wrisberg. 21. Coraco-brachialis. 22. Intercosto-humeral nerve. 23. Ulnar nerve. 24. Subscapularis. 25. Brachial artery. 26. Lateral cutaneous branch of 3d intercostal nerve. 27. Middle subscapular nerve. 28. Short subscapular nerve. 29. Long subscapular nerve. 30. Pectoralis major (cut). 31. Basilic vein (cut). 32. Serratus magnus. 33. Latissimus dorsi.

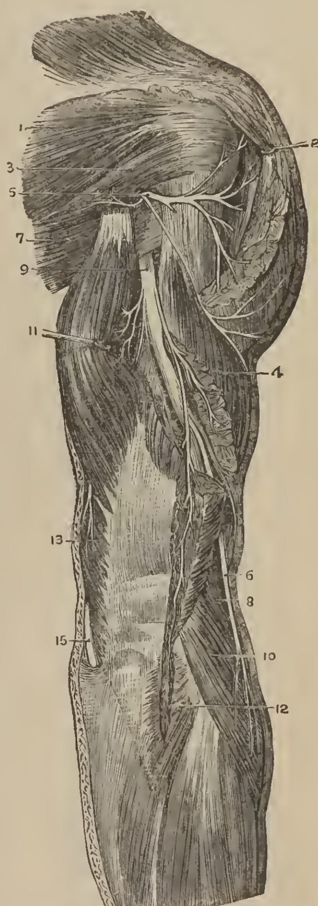
the skin of the lower part of the forearm; communicating also with the radial nerve, and with the external cutaneous branch of the musculo-spiral nerve.

The *internal cutaneous* nerve is a small branch of the brachial

plexus. From its origin at the inner side of the brachial artery, it goes down along the arm to near its middle, when it emerges with the basilic vein, and divides into two cutaneous branches. Of these, the *anterior* branch goes usually in front of the median basilic vein; occasionally, behind it. Then it passes down on the anterior surface of the ulnar side of the forearm to the wrist. The *posterior* branch winds over the inner condyle of the humerus to the back of the forearm and is there distributed to the integument.

The *lesser internal cutaneous* nerve (nerve of Wrisberg) is the smallest branch of the brachial plexus. Passing through the axilla near the axillary vein, it goes with the brachial artery to the middle of the arm; then, perforating the fascia, it is distributed to the skin of the back of the arm.

Fig. 106.



DISSECTION OF BACK OF UPPER ARM.—1. Infra-spinatus. 2. Deltoid. 3. Teres minor. 4. Outer head of triceps. 5. Circumflex nerve. 6. External cutaneous branch of musculo-spiral nerve. 7. Teres major. 8. Supinator longus. 9. Musculo-spiral nerve. 10. Extensor carpi radialis longior. 11. Middle head of triceps. 12. Anconeus. 13. Inner head of triceps. 15. Ulnar nerve.

Median Nerve.

The *median* is an important nerve. Its two roots, from the brachial plexus, embrace the axillary artery, and then unite into one trunk. This descends the arm, at first outside, and then crossing to the inner side, of the brachial artery, to the bend of the elbow, over the brachialis anticus muscle. Then it passes between the two heads of the pronator radii teres muscle, and under the flexor sublimis digitorum, to become more superficial two inches above the wrist. Thence it passes under the annular ligament to the hand.

No branches go from the median nerve till it reaches the fore-

arm. Then it gives off the *muscular*, *anterior interosseous*, and *palmar cutaneous* branches.

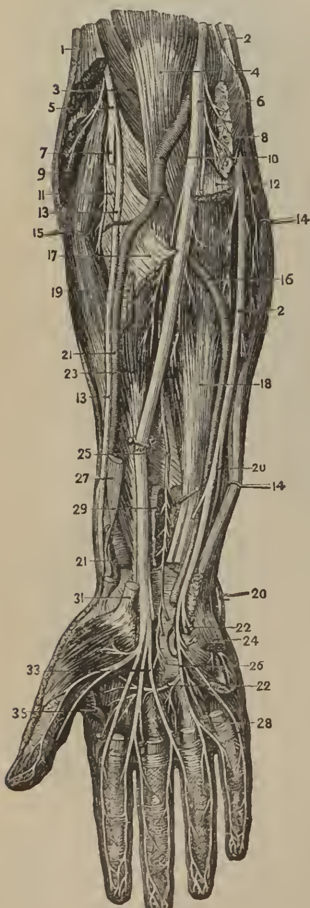
The *muscular* branches supply the superficial muscles in front of the forearm, except the flexor carpi ulnaris.

The *anterior interosseous* nerve goes to the deep muscles of the front of the forearm.

The *palmar cutaneous* nerve arises low down and divides above the annular ligament into an *outer* branch for the ball of the thumb, and an *inner* one for the palm of the hand.

The median nerve, reaching the palm, outside of the flexor tendons, divides into an *external* and an *internal* branch. The former supplies the muscles of the thumb and forefinger; the internal, the middle finger and part of the forefinger and third finger. Each of the five digital branches gives off a dorsal branch, which runs along the side of the back of a finger to its end. There it divides into a dorsal and a palmar branch, for the extremity of the finger.

Fig. 107.



Deep Dissection of the Front of the Forearm and Hand.—1. Supinator longus (cut). 2. Ulnar nerve. 3. Brachialis anticus. 4. Biceps. 5. Musculo-spiral nerve. 6. Median nerve. 7. Posterior interosseous nerve. 8. Pronator teres and flexor carpi radialis (cut.) 9. Extensor carpi radialis longior (cut). 10. Brachial artery. 11. Supinator brevis. 12. Flexor sublimis digitorum (cut). 13, 13. Radial nerve. 14, 14. Flexor carpi ulnaris. 15. Extensor carpi radialis brevior. 16. Ulnar artery. 17. Radial origin of flexor sublimis digitorum (cut). 18. Flexor profundus digitorum. 19. Tendon of pronator teres (cut). 20, 20. Dorsal branch of ulnar nerve. 21, 21. Radial artery. 22, 22. Deep branch of ulnar nerve. 23. Flexor longus pollicis. 24. Abductor minimi digiti. 25. Anterior interosseous nerve. 26. Digital branches of ulnar nerve. 27. Tendon of supinator longus (cut). 28. One of the lumbricales muscles (cut). 29. Pronator quadratus (cut open). 31. Tendon of flexor carpi radialis (cut). 33. Digital branches of median nerve. 35. Abductor pollicis.

Ulnar Nerve.

This is behind the median nerve at its origin, and is smaller. Going on the inner side of the axillary and brachial artery, at the middle of the arm it runs obliquely across to descend between the olecranon process and the inner condyle of the humerus. It reaches the foramen between the two heads of the flexor carpi ulnaris muscle. Descending along the ulnar side of the forearm, it goes outside of the pisiform bone at the wrist, and, just below that bone, divides into the *superficial* and *deep palmar* nerves. Besides these, its branches are, the *articular*, *muscular*, *cutaneous*, *dorsal cutaneous*, and *carpal articular*.

The upper *articular* branches are several small ones for the elbow-joint.

The two *muscular* branches pass off near the elbow to the flexor muscles.

The *cutaneous* arises about the middle of the forearm, and subdivides into superficial and deep cutaneous branches.

The *dorsal cutaneous* passes from about two inches above the wrist, backwards beneath the flexor carpi ulnaris to the ulnar side of the wrist and the inner side of the little finger and adjoining sides of the little and the third or ring finger; communicating also with a branch of the radial nerve.

The lower *articular* filaments go to the wrist.

The *superficial palmar* terminal branch of the ulnar nerve supplies the skin on the inner side of the hand, and sends two digital branches; one to the ulnar side of the little finger, the other to the adjoining sides of the little and ring fingers.

The *deep palmar* branch follows the course of the deep palmar arterial arch beneath the flexor tendons; and sends filaments to the small muscles of the hand.

Musculo-Spiral Nerve.

The *musculo-spiral* nerve is the largest one that goes off from the brachial plexus. It passes behind the axillary artery and down in front of the tendons of the teres major and latissimus dorsi muscles; winds around the humerus with the superior profunda vessels, and then, on the outside of the arm, descends between the branchialis anticus and supinator radii longus to the front of the external condyle. There it subdivides into the *radial* and *posterior interosseous* nerves.

Its branches are, besides these, the *muscular* and *cutaneous*.

The *muscular* branches go to the triceps, anconeus, supinator longus, extensor carpi radialis longior, and brachialis anticus muscles.

The three *cutaneous* branches are, one *internal* and two *external*. They arise in or near the axillary space, and are distributed to the tegument, the lowest extending to the wrist.

Radial Nerve.

The *radial* nerve runs down on the front of the radial side of the forearm, two-thirds of its length, outside of the radial artery.

Then it leaves that vessel, perforates the fascia outwards, and divides into an *external* and an *internal* branch. The former is small, and cutaneous in its distribution. The internal forms an arch on the back of the hand with the dorsal branch of the ulnar nerve. Then it gives off four digital nerves; one to the ulnar side of the thumb, one to the radial side of the forefinger, a third to the adjoining sides of the fore and middle fingers, the fourth to the adjoining sides of the middle and ring fingers.

The *posterior interosseous* nerve pierces the supinator radii brevis muscle, winds to the back of the forearm, and then passes down between the superficial and the deep layers of muscles to the middle of the forearm. Thence, over the interosseous ligament it reaches the back of the wrist; and, having a ganglion-like enlargement, gives off filaments from it to the wrist-joint. The branches of this nerve supply many of the muscles of the radial side and back of the forearm.

Twelve Dorsal Nerves.

The anterior branches of these, on each side, are the *intercostal* nerves. The posterior branches are smaller; they divide into *external* and *internal* ramifications. Their distribution is to the superficial and deep muscles of the back. Twelve pairs of *cutaneous* branches go off, six above from the internal, and six from the external posterior dorsal nerves.

Intercostal Nerves.

These are twelve on each side. The upper six go only to the chest (except the first); the lower six supply also the walls of the abdomen. The nerves of both sets go forward in the intercostal spaces below the artery and veins as far as the anterior terminations of the intercostal spaces. Those of the *upper* set, near the sternum, cross the internal mammary artery, penetrate the intercostal and pectoralis major muscles, and become the *anterior cutaneous* thoracic nerves. The *lower* ones, anteriorly, pass behind the costal cartilages, and between the internal oblique and transversalis muscles, to supply the rectus abdominis muscle; and afterwards become cutaneous. *Lateral cutaneous* nerves go off from the intercostal nerves, half way between the spine and the sternum.

The *first* intercostal nerve has no lateral cutaneous branch. That of the *second* is the *intercosto-humeral* nerve. Perforating the external intercostal muscle, it crosses the axilla to the inner side of the arm; there becoming cutaneous, and communicating with the cutaneous nerves of the arm. Sometimes the *third* intercostal nerve also gives off an intercostal humeral branch.

Ths *first dorsal* nerve has but a small intercostal branch; its anterior trunk mainly going into the brachial plexus.

The *last dorsal* nerve has a very large lateral cutaneous branch; reaching, in its distribution, as far as the surface over the hip-joint.

Five Lumbar Nerves.

The *anterior* branches of these, besides communicating with the sympathetic, send off muscular branches. Those of the *first four*

lumbar nerves form the *lumbar plexus.* That of the *fifth* joins the sacral plexus, in a trunk with the anterior branch of the sacral nerve (lumbo-sacral nerve).

The *posterior* lumbar branches subdivide into external and internal; and are then distributed to the muscles of the lumbar region.

Lumbar Plexus.

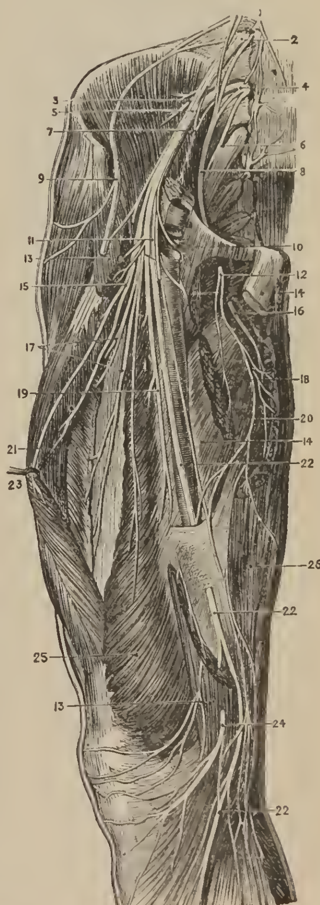
This is located upon or in the psoas magnus muscle, near the transverse processes of the vertebræ, on each side. Its branches are, the *ilio-hypogastric*, *ilio-inguinal*, *genito-crural*, *external cutaneous*, *obturator*, *accessory obturator*, and *anterior crural* nerves.

Of these, the *ilio-hypogastric*, *ilio-inguinal*, and part of the *genito-crural* nerves are distributed to the lower abdominal walls. The rest of the *genito-crural* and the *external cutaneous*, *obturator*, *accessory obturator*, and *anterior crural* nerves, supply the forepart of the thigh and the inner side of the leg.

Anterior Crural Nerve.

This is the largest branch of the lumbar plexus. It sends muscular branches to the *iliacus internus* and *pectineus* muscles,

Fig. 108.



NERVES OF THE THIGH.—1. Gangliated cord of sympathetic. 2. Third lumbar nerve. 3. Branches to iliacus internus. 4. Fourth lumbar nerve. 5. Anterior crural nerve. 6. Lumbo-sacral nerve. 7. Branch to psoas. 8 Obturator nerve. 9. External cutaneous nerve (cut). 10. Nerve to pectineus. 11. Superficial division of anterior crural nerve (cut). 12. Superficial division of obturator nerve. 13, 13. Sartorius muscle. 14, 14. Adductor longus. 15. Branch to rectus. 16. Deep division of obturator nerve. 17 Branches to vastus externus and crureus. 18. Adductor brevis. 19. Branch to vastus internus. 20. Adductor magnus. 21. Vastus externus. 22, 22. Internal saphenous nerve. 23. Rectus femoris. 24. Patellar branch of saphenous nerve. 25. Vastus internus. 26. Gracilis.

and to all the muscles on the anterior part of the thigh; also, cutaneous and articular branches.

In its course, the anterior crural nerve goes down between the psoas magnus and iliacus internus muscles, beneath Poupart's ligament, to the thigh; there dividing into an anterior cutaneous and a posterior muscular portion. From the anterior part, it gives off the *middle cutaneous*, *internal cutaneous*, and *long saphenous* nerves; from the posterior part, *muscular* and *articular* branches.

The *long* or *internal saphenous* nerve is the largest of the cutaneous branches. It lies outside of the femoral artery from its passage beneath the sartorius muscle to the opening in the lower part of the adductor magnus. Thence it descends vertically along the inner side of the knee; penetrates the deep fascia between the tendons of the sartorius and gracilis muscles, and, becoming subcutaneous, goes down the inner side of the leg with the internal saphenous vein. In the lower third of the leg it divides into two terminal branches. One goes along the tibia to the inner malleolus; the other is distributed to the inner side of the foot, as far as the great toe.

Sacral and Coccygeal Nerves.

These are six on each side; the last one called coccygeal. The collection of their long roots together at the lower end of the spinal marrow makes the *cauda equina*. The lumbo-sacral nerve and the anterior branches of the three upper, and part of the fourth sacral nerve, form the *sacral plexus*.

Sacral Plexus.

This gives off from within the pelvis on each side the following branches: *muscular*, *superior gluteal*, *pudic*, *lesser sciatic*, and *great sciatic* nerves.

The *muscular* branches go to the pyriformis, obturator internus, gemelli, and quadratus femoris muscles.

The *superior gluteal* nerve passes with the gluteal bloodvessels through the great sacro-sciatic foramen; and then divides into a *superior* and an *inferior* branch. The former goes to the glutei muscles; the latter also to the tensor vaginæ femoris.

The *pudic* nerve leaves the pelvis through the great sacro-sciatic foramen, crosses the spine of the ischium, and then re-enters the pelvis by the lesser sacro-sciatic foramen. It goes with the pudic vessels upwards and forwards, and divides into the *perineal* and *dorsalis penis* nerve. A previous branch of it is the *inferior hemorrhoidal* nerve; which goes to the sphincter ani muscle and the integument around the anus.

The *perineal* nerve lies below the pudic artery, and divides into *cutaneous* and *muscular* branches; the *cutaneous*, into an anterior and a posterior branch.

The *dorsal nerve of the penis* runs with the pudic artery along the ramus of the ischium, and then penetrates the suspensory ligament of the penis and passes with the dorsal artery of the penis to the glans. In the female, the superior division of the pudic nerve

goes to the clitoris; the inferior, to the external labia and the perineum.

The *small sciatic* nerve is distributed to the skin of the perineum, the back of the thigh, and the gluteus maximus muscle. Its branches are *muscular* or inferior gluteal, and *internal* and *ascending cutaneous* branches.

Great Sciatic Nerve.

This is the largest nerve in the body. Passing out through the great sacro-sciatic foramen it goes down between the tuberosity of the ischium and the trochanter major to the back of the thigh, and, at its lower third, divides into the *internal* and *external popliteal* nerves.

Before dividing, it sends off *articular* and *muscular* branches; the first to the hip-joint, the last to the flexor muscles on the back of the thigh.

The *internal popliteal* nerve passes down through the popliteal space, back of the knee, to the lower part of the popliteus muscle; then, with the artery, to become, under the arch of the

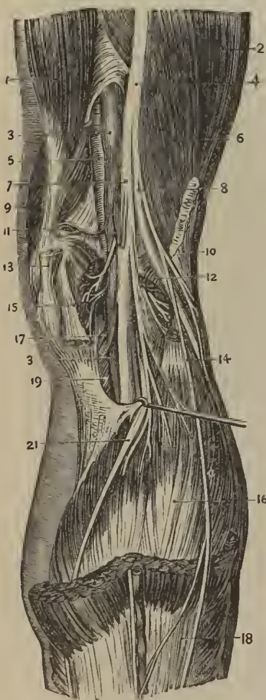
Fig. 109.

Buttock and Back of the Thigh.—1. Gluteus maximus. 2. Gluteus medius. 3. Gluteal artery and nerve. 4. Gluteus minimus. 5. Nerve to obturator internus. 6. Pyriformis. 7. Pudic nerve. 8. Small sciatic nerve. 9. Great sacro-sciatic ligament. 10. Obturator internus and gemelli. 11. Inferior gluteal nerve from small sciatic. 12. Tendon of obturator externus. 13. Inferior pudendal nerve (Soemmering). 14. Quadratus femoris. 15. Gracilis. 16. Great sciatic nerve. 17 Adductor magnus. 18. Insertion of gluteus maximus. 19. United origins of semi-tendinosus and biceps. 20. Short head of biceps. 21. Semimembranosus. 22. Tendon of biceps. 23. Tendon of semi-tendinosus. 24. External popliteal nerve. 25. Internal popliteal nerve. 26. Communicans fibularis [or c. peronei] nerve. 27. Popliteal artery. 29. Gastrocnemius. 31. Communicans tibialis [or external saphenous] nerve.

soleus muscle, the *posterior tibial* nerve. Its branches, before this, are the *articular*, *muscular*, and *external* or *short saphenous* nerves.

The *articular* branches go to the knee-joint. The *muscular*, to the muscles of the calf of the leg. The *external* or *short saphenous* nerve descends between the heads of the gastrocnemius muscle, perforates the fascia at the middle of the leg, and, with a branch (*communicating peroneal* nerve) from the external popliteal nerve, goes down the outer margin of the tendo Achillis; then, with the external saphenous vein it winds around the external malleolus and is distributed to the skin on the outer side of the foot.

Fig. 110.



The *posterior tibial* nerve descends with the posterior tibial vessels to the space between the internal malleolus and the heel; there dividing into the *external* and *internal plantar* nerves. Above, it lies to the inner side of the artery; soon, however, it crosses it, and keeps to its outer side to the ankle. Its branches are *muscular* and *plantar cutaneous;* besides the two terminal branches, external and internal plantar. The *muscular* ones go to the deep muscles of the leg; the *plantar cutaneous*, to the heel and the sole of the foot.

The *internal plantar* nerve goes with the internal plantar artery along the inner side of the foot. Opposite the bases of the metatarsal bones it gives off four terminal *digital* branches; communicating also with the external plantar nerve. Before these, it gives off *cutaneous muscular*, tarsal, and metatarsal *articular* branches of the foot.

The *external plantar* nerve supplies the little toe and half of the fourth toe, as well as some of the muscles of the foot.

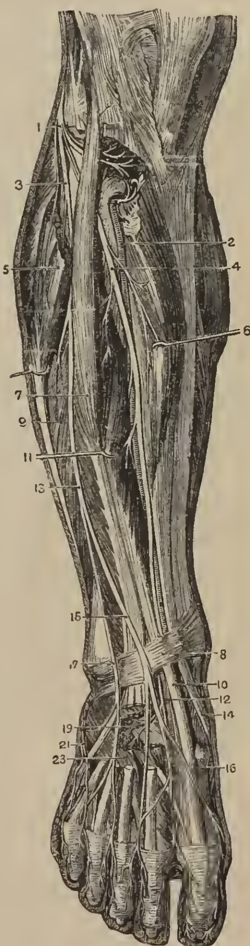
The *external popliteal* or *peroneal* nerve descends obliquely in the popliteal space near the margin of the biceps muscle to the fibula. An inch below the head of that bone it perfo-

Popliteal Space.—1. Adductor magnus. 2. Vastus externus. 3. Popliteal vein. 4. Great sciatic nerve. 5. Popliteal artery. 6. Short head of biceps. 7. Internal popliteal nerve. 8. External popliteal nerve. 9. Vastus internus. 10. Long head of biceps (cut). 11. Superior internal articular artery. 12. Outer head of gastrocnemius. 13. Tendon of semi-membranosus. 14. Communicans peronei nerve. 15. Inner head of gastrocnemius. 16. Soleus. 17. Inferior internal articular artery. 18. Gastrocnemius. 19. Popliteus. 20. External saphenous vein and nerve. 21. Tendon of plantaris.

rates the peroneus longus muscle and divides into the *anterior tibial* and *musculo-cutaneous* nerves. Before dividing, it gives off two *articular* branches to the knee, and two or three *cutaneous* branches to the back and outer side of the leg.

The *anterior tibial* nerve runs obliquely forwards under the extensor digitorum, joining the anterior tibial artery, on its outside, above the middle of the leg. Then descending with the artery to the front of the ankle, it divides into an *internal* and an *external* branch. Before this, it gives off some *muscular* branches to the leg.

Fig. 111.



The *internal* branch goes with the dorsal artery of the foot along the inner side of the latter, and divides into two branches for the adjoining sides of the great toe and the second toe.

The *external* or *tarsal* branch of the anterior tibial nerve goes outwards across the tarsus, and forms a ganglion like enlargement; from which proceed branches to the extensor brevis of the toes and the tarsal and metatarsal articulations.

The *musculo-cutaneous* branch of the external popliteal or peroneal nerve passes forwards to penetrate the deep fascia at the lower third of the leg, in front and on the outer side. Then it divides into an *internal* and an *external* branch; having, first, given off some *muscular* and *cutaneous* branches.

The *internal* of these branches goes in front of the ankle and along the dorsum of the foot to the great toe, and the adjacent sides of the second

Front of the Leg.—1. External popliteal nerve. 2. Anterior tibial artery. 3. Musculo-cutaneous nerve. 4. Anterior tibial nerve. 5. Peroneus longus 6. Tibialis anticus. 7. Extensor longus digitorum. 8. Anterior annular ligament. 9. Peroneus brevis. 10. Tendon of extensor proprius pollicis. 11. Extensor proprius pollicis. 12. Dorsal artery of foot. 13. Point at which musculo-cutaneous nerve pierces the fascia and divides. 14. Tendon of tibialis anticus. 15. Internal branch of musculo-cutaneous nerve. 16. Cutaneous branch of anterior tibial nerve. 17. External branch of musculo-cutaneous nerve. 19. Deep branch of anterior tibial nerve. 21. External saphenous nerve. 23. Extensor brevis digitorum.

and third toes; also supplying the skin over and above them. It communicates with the internal saphenous nerve, as well as with the anterior tibial nerve.

The *external* terminal branch of the musculo-cutaneous nerve is larger. It runs along the outside of the dorsum of the foot, to the adjacent sides of the third, fourth, and fifth toes, and to the integument of the outer ankle, and outer side of the foot.

SYMPATHETIC NERVE.

This, the *ganglionic system* of physiologists, consists of a series of ganglia, connected together, and communicating with the spinal marrow and various organs and vessels, by cords of gray and white nerve filaments.

The ganglia of the two sides meet above, at the ganglion of Ribes, upon the anterior communicating artery of the brain. Below, they converge to the *ganglion impar* in front of the coccyx.

The ganglia or centres of the sympathetic system are numerically as follows: four *cephalic;* three *cervical;* twelve *dorsal;* four *lumbar;* five *sacral;* and one *coccygeal* ganglion. Their branches are: 1. Communicating branches between the ganglia. 2. Branches connecting the ganglia with the cephalic or spinal nerves. 3. Branches distributed to the arteries, to the viscera, and to the thoracic, abdominal, and pelvic ganglia and plexuses.

Cephalic Ganglia.

Ophthalmic, *ciliary*, or *lenticular ganglion.*—This is a flattened vesicular mass of about the size of a pin's head, at the back of the orbit of the eye, between the optic nerve and the external rectus muscle. Its *communicating* branches are three: one with the nasal branch of the ophthalmic nerve, or first branch of the fifth pair. Another, with a branch of the third or motor oculi nerve. The other connects with the cavernous plexus of the sympathetic. Its branches of *distribution* are the *short ciliary* nerves, ten or twelve, going to the ciliary muscle and iris.

Spheno-palatine, or *Meckel's ganglion.*—This is the largest of those of the head. It is located in the spheno-maxillary fossa; and has a somewhat triangular shape. Its roots (as some anatomists call the communicating filaments) are, one from the facial (portio dura of seventh pair) through the vidian; one from the fifth; and one from the carotid plexus of the sympathetic, through the vidian nerve.

Its small *ascending* branches go into the orbit by the spheno-maxillary fissure, and supply its periosteum.

The *palatine* branches of this ganglion are the *anterior*, *middle*, and *posterior palatine nerves.* The *anterior* goes down through the posterior palatine canal, out by the posterior palatine foramen upon the hard palate, and passes forwards in a groove of the latter almost to the incisor teeth. In the canal, it sends off inferior nasal filaments, which go to ramify in the middle meatus and the turbinated bones.

The *middle* palatine nerve goes through the same canal as the

above, to the posterior palatine foramen, giving off branches to the tonsil, soft palate, and uvula.

The *posterior* palatine nerve goes through the small posterior palatine canal, emerging behind the posterior palatine foramen; to be distributed to the soft palate, uvula, and tonsil.

The *internal* branches of Meckel's ganglion are the *anterior superior nasal* and the *naso-palatine* nerves. The former are four or five; they enter the nasal fossa through the spheno-palatine foramen, and supply its mucous membrane.

The *naso-palatine* nerve (nerve of Cotunnius) enters the nasal fossa with the above, goes inwards to the septum narium, then downwards and forwards along the septum to the anterior palatine foramen. It grows down to the roof of the mouth, where those of the right and left sides join, and supply the mucous membrane.

Posterior branches of the spheno-palatine ganglion are, the *Vidian* nerve and the *pharyngeal* or pterygo-palatine nerve. The *Vidian* nerve runs through the Vidian canal to the foramen lacerum, and divides into the *large petrosal* and the *carotid* branches.

The *large petrosal* nerve passes beneath the ganglion of Casser in a groove of the petrous part of the temporal bone; then through the hiatus Fallopii into the aqueductus Fallopii, connecting with the ganglionic enlargement of the facial nerve.

The *carotid* branch of the Vidian enters the carotid canal of the temporal bone, outside of the artery, and joins the carotid plexus. A ganglionic enlargement upon it is called the carotid ganglion, or *ganglion of Laumonier*.

The *pharyngeal* nerve goes through the pterygo-palatine canal with the artery of that name, to the mucous membrane of the pharynx.

Otic ganglion (of Arnold).—This is a small, flattened, oval ganglion, located below the foramen ovale, upon the third branch of the fifth nerve. The cartilaginous portion of the Eustachian tube is at its internal side. It communicates with the third branch of the fifth pair, with the sympathetic plexus around the middle meningeal artery; and with the glosso-pharyngeal of the eighth, and the facial of the seventh pair, through the small petrosal nerve. Branches from this ganglion are distributed to the tensor tympani and tensor palati muscles.

Sub-maxillary ganglion.—This is small and circular, located near the posterior margin of the mylo-hyoid muscle. It is connected with the gustatory nerve, with the chorda tympani, and with the *nervi molles* of the sympathetic which surround the facial artery. Branches go from it, five or six in number, to the mucous membrane of the mouth, and to the submaxillary gland and its duct.

Cervical Ganglia.

These are three on each side; the *superior*, *middle*, and *inferior* ganglia of the neck.

The *superior* is largest. It is opposite to the second and third, sometimes fourth cervical vertebræ. In front of it are the internal carotid artery, jugular vein, and glosso-pharyngeal nerve; behind it, the rectus capitus anticus major muscle; outside of it, the

pneumogastric nerve. Its branches are *superior*, *inferior*, *external*, *internal*, and *anterior*.

The *superior* branch runs into the carotid canal, and divides into an *inner* and an *outer* branch, both distributed to the internal carotid artery. On the *inner*, the *cavernous plexus* is formed; on the *outer* branch, the *carotid* plexus.

The *inferior* branch of the first cervical ganglion connects with the second or middle ganglion.

Fig. 112.

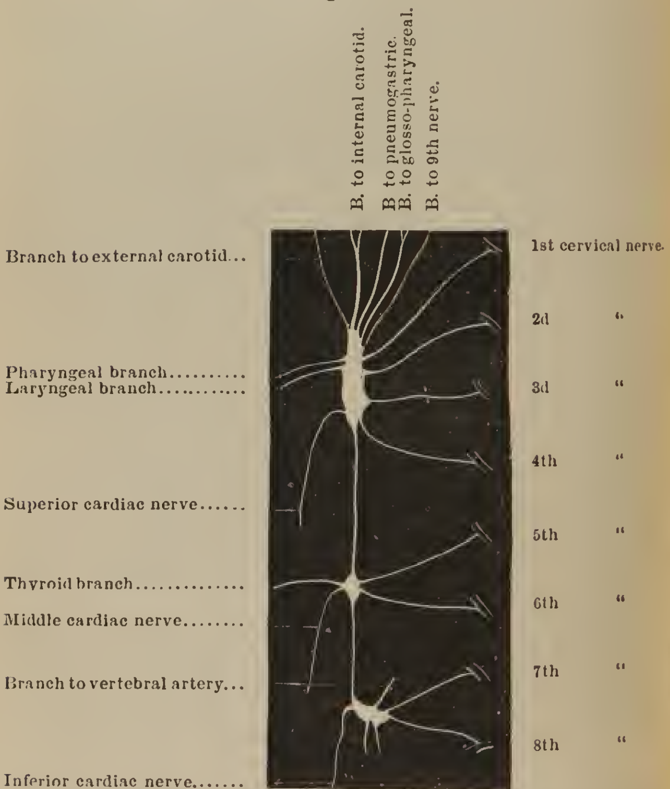


Diagram of the Superior, Middle, and Inferior Cervical Ganglia of the Sympathetic.

The *external* branches are numerous. They communicate with the cephalic nerves, and with the four upper spinal nerves.

The *internal* ones are three: the *pharyngeal* and *laryngeal* branches, and the *superior cardiac* nerve. The last-named, on the

right side, goes to the deep cardiac plexus; on the left side, to the superficial cardiac plexus.

The *anterior* branches of the same ganglion (nervi molles) form plexuses about the external carotid artery and its branches.

The *middle* cervical ganglion is the smallest of the three. It lies opposite to the fifth cervical vertebra, close to the inferior thyroid artery.

Its *superior* branches go up to the superior ganglion; its *inferior* ones, down to the inferior ganglion. *External* branches pass to the fifth and sixth spinal nerves. Its *internal* branches are the *thyroid* nerves, to the thyroid artery and gland, and the *middle cardiac* nerve. This last nerve goes to the deep cardiac plexus.

The *inferior* cervical ganglion lies near to the neck of the first rib. Its *superior* branches go up to the middle ganglion; its *inferior* ones, down to the first thoracic ganglion. Among them is the *inferior cardiac* nerve, which joins the deep cardiac plexus. Some *external* branches connect with the seventh and eighth spinal nerves; others form a plexus around the vertebral artery.

Cardiac Plexuses.

These are the *superficial* cardiac plexus, the *deep* cardiac plexus, and the *anterior* and *posterior coronary* plexuses.

The *superficial cardiac* plexus is beneath the arch of the aorta, in front of the right pulmonary artery. It is supplied by the left superior cardiac nerve, the left, and sometimes the right, inferior cardiac branches of the pneumogastric, and connecting branches from the deep cardiac plexus. It sends filaments to form the anterior coronary plexus, and some to the left anterior pulmonary plexus.

The *great* or *deep cardiac* plexus lies in front of the bifurcation of the trachea, behind the arch of the aorta. It is formed by the cardiac nerves already described, and by the cardiac branches of the pneumogastric and recurrent laryngeal nerves. This plexus supplies the posterior coronary plexus and part of the anterior coronary plexus; sending filaments also to the auricles of the heart and the pulmonary plexuses.

The *anterior coronary* plexus lies with the right coronary artery on the anterior surface of the heart.

The *posterior coronary* plexus embraces the branches of the coronary artery upon the back of the heart.

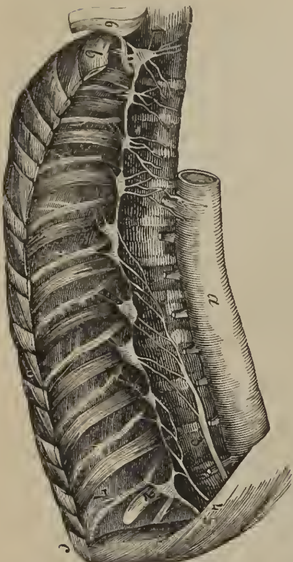
Beneath the endocardium Valentin and Robert Lee have demonstrated the existence of fine nervous ramifications, some within the substance of the heart, having many ganglia upon them.

Thoracic Ganglia.

These are usually twelve; placed on each side of the vertebral column, against the heads of the ribs. They have, each, two *external* branches, connecting with the dorsal spinal nerves. From the *upper six* ganglia, small *internal* branches go to the thoracic aorta and its branches; the third and fourth give filaments also to the pulmonary plexus.

Internal branches pass from the *six lower* thoracic ganglia to unite

Fig. 113.



THORACIC GANGLIA.—*a.* Aorta. *b.* First rib. *c.* Eleventh rib. 1. First thoracic ganglion. 2. Last thoracic ganglion. 3. Great splanchnic nerve. 4. Lesser splanchnic nerve. 5. Renal splanchnic. 6. Part of brachial plexus.

and form the *great splanchnic*, *lesser splanchnic*, and the *renal splanchnic* nerves.

The *great splanchnic* nerve is whiter than the ordinary ganglionic nerves. It goes obliquely downwards and inwards to penetrate the diaphragm, and enter the semilunar ganglion.

The *lesser splanchnic* nerve also perforates the diaphragm, and connects with the cœliac plexus.

The *renal* or *smallest* splanchnic nerve goes from the lowest thoracic ganglion through the diaphragm to join the renal plexus, as well as the lower part of the cœliac plexus.

Solar Plexus.

This name is given to a dense network of nerves and ganglia, behind the stomach, and front of the aorta. It is the termination of the great splanchnic nerves, part of the lesser sphlanchnic, and the right pneumogastric nerve. Branches from it form plexuses which surround the branches of the abdominal aorta.

The *semilunar ganglia*, one on each side, are the largest ganglia in the body. They lie very near to the supra-renal capsules and the cœliac axis artery.

The plexuses connected with or proceeding from the solar plexus are named as follows: *phrenic*, *cœliac*, *gastric*, *hepatic*, *splenic*, *supra-renal*, *renal*, *superior mesenteric*, *spermatic*, and *inferior mesenteric* plexuses. They accompany the arteries of corresponding names. The *aortic* plexus is also formed by branches of the solar and renal plexuses, receiving some filaments from the lumbar ganglia.

Lumbar Ganglia.

These are four, lying in front of the spinal column. *Superior* branches connect each with the ganglion above it; *inferior* ones, with that next below; and *external* branches, with the lumbar spinal nerves. *Internal* branches go in part to the aortic plexus; some to form the *hypogastric* plexus over the promontory of the sacrum.

Pelvic Ganglia.

Of these there are four or five in front of the sacrum. They approach below, and unite in the *ganglion impar* on the front of

the coccyx. The distribution of their branches closely resembles that of those of the lumbar ganglia.

The *hypogastric plexus* is formed by nerves from the two upper pelvic ganglia, the lumbar ganglia, and aortic plexus. Its branches are sent to the pelvic viscera.

The *inferior hypogastric* or *pelvic* plexus is an extension downwards of the above; supplied from the three or four lower pelvic ganglionic branches on each side, and some filaments directly from the ganglia. It lies by the side of the rectum and bladder in the male; by the rectum, bladder, and vagina in the female. From it branches go to all the pelvic viscera, with the branches of the iliac artery.

Back of it, from its branches, is formed the *inferior hemorrhoidal* plexus. In front of it, the *vesical* plexus. Below it, the *prostatic* plexus. The nerves from this last are large, and pass in the male to the vesiculæ seminales, prostate, and erectile structure of the penis. The *large* and *small cavernous* nerves are the principal branches.

In the female, the *vaginal* plexus is below the pelvic or inferior hypogastric pelvis. It supplies the vagina.

From the *hypogastric* plexus pass off the nerves that supply the uterus. In the substance of that organ, as in that of the heart, Dr. Robert Lee has shown the existence of nervous filaments and ganglia.

CHAPTER X.

ORGANS OF SPECIAL SENSE.

THE EYE.

The eyeball is nearly globular. Its coats are the *conjunctiva*, *sclerotic*, *choroid*, and *retina*. The transparent refracting media are the *cornea*, *aqueous humor*, *crystalline lens*, and *vitreous humor*.

Interior parts, connected with the choroid coat, are, also, the *iris*, *ciliary ligament* and *muscle*, and *ciliary processes*. Appendages of the eye are the eyelids, eyelashes, eyebrows, lachrymal gland, Meibomian glands and ducts; muscles, nerves, and bloodvessels.

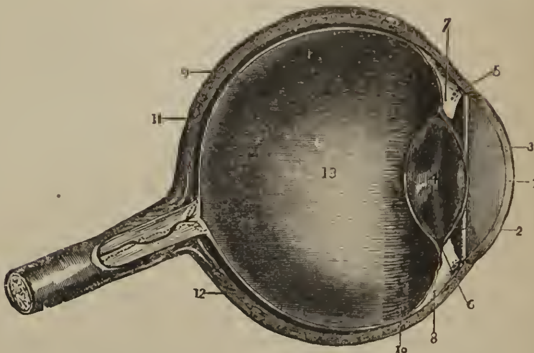
The *conjunctiva* is a mucous membrane which lines the eyelids and is reflected over the front part of the sclerotic and the cornea. Near the inner angle of the eye it forms a fold called *plica semilunaris*. The *caruncula lachrymalis* is at the inner side of this; it is a small, reddish, conical enlargement, consisting of follicles.

The *sclerotic*, or hard coat of the eye, is fibrous in structure. Externally, it is white; internally, brownish, and marked with grooves for the ciliary nerves. The muscles of the eyeball are inserted into it. The optic nerve perforates it. In front, the cornea is continuous with its edge; being set into it as a watch-glass in its case.

The *cornea* projects anteriorly, constituting about one-sixth of

the ball of the eye. It is most prominent in early life. Its proper tissue is fibrous, covered in front and behind by elastic laminæ. No capillaries extend into the cornea.

Fig. 114.



LONGITUDINAL SECTION OF THE EYE.—1. Cornea. 2. Iris. 3. Anterior chamber communicating with the posterior chamber through the pupil. [The posterior chamber is the triangular space (when seen in section) inclosed by the iris, the ciliary processes, and the lens.] 4. Lens inclosed in its capsule. 5. Canal of Fontana [or of Schlemm, often called the circular sinus]. 6. Canal of Petit 7. Ciliary process. 8 Ciliary muscle. 9. Retina. 10. Ciliary zone [or zone of Zinn]. 11. Sclerotic. 12. Choroid. 13. Vitreous humor.

The *choroid* coat is beneath the sclerotic. It has three layers. The *external* layer consists of the branches of the short ciliary arteries and, in greater number, the curved veins called *venæ vorticosæ*. Among the vessels are stellate pigment-cells. The *middle* layer (tunica Ruyschiana) is a plexus of fine capillaries from the short ciliary arteries. The *internal pigmentary* layer consists of six-sided pigment-cells, with nuclei and color-granules within them.

The *ciliary processes* are folds of the anterior margin of the choroid coat, making a circle around the edge of the crystalline lens, behind the iris. They are from sixty to seventy in number. Their bloodvessels are large. The *zone of Zinn* is a ring of folds radiating around the lens and fitting into those of the ciliary processes.

The *iris* is a circular curtain, suspended behind the cornea in the aqueous humor; with a central aperture, the pupil. Its circumference is connected in part with the choroid, and, outside of that, by the ciliary ligament, with the sclerotic and cornea at their junction. It is composed of a fibrous stroma or central tissue, with commingled muscular fibres. These are the *radiating* muscular fibres, reaching to the circumference, and the *circular* ones, surrounding the pupil. Pigment-cells are also contained in it, giving the different colors to the eyes of different persons. Behind, the iris is purple; this surface is called the *uvea*.

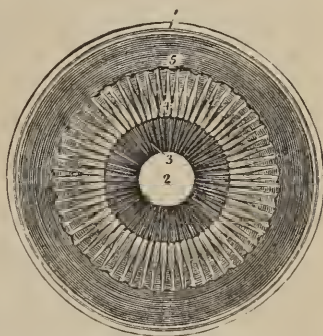
The *ciliary ligament* is a narrow circle around the circumference

of the iris, at the place of its union with the choroid, sclerotic, and cornea. A minute canal exists where it joins the sclerotic, the *sinus circularis iridis.*

The *ciliary muscle* is a circular band of unstriped fibres, longitudinal in direction, connecting the junction of the sclerotic and cornea with the choroid coat. Its action is upon the ciliary processes, and perhaps upon the lens.

The *retina* is the innermost coat of the eye. Outside of it is the choroid; within it, the vitreous humor. The optic nerve enters it a little to the inner side of the centre of the ball. Anteriorly it terminates a little behind the ciliary ligament, in a jagged edge, the *ora serrata.* Exactly in the centre of its posterior part, in the axis of the eye, is the *yellow spot of Sœmmering,* the point of most perfect vision. The *central artery of the retina* enters through the centre of the optic nerve. This point is destitute of vision.

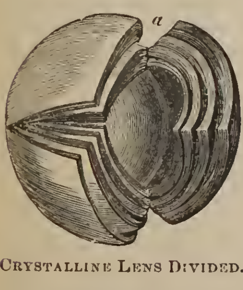
Fig. 115.



TRANSVERSE SECTION OF THE EYE.—1. Edge of sclerotic, choroid, and retina. 2. Pupil. 3. Iris. 4. Ciliary processes. 5. Border of retina.

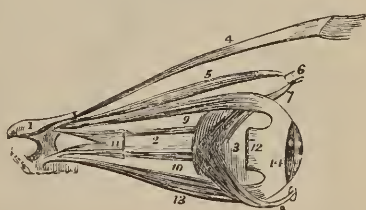
The retina consists of three (Kölliker says four) layers: 1, external, *Jacob's membrane,* layer of *rods and cones;* 2, middle, *granular layer;* 3, internal layer; *expansion of the optic nerve* into a network, and arrangement of *nerve-cells.* The fine *fibres of Müller* penetrate these different layers. A very delicate membrane, *membrana limitans,* separates the retina from the vitreous humor.

Fig. 116.



CRYSTALLINE LENS DIVIDED.

Fig. 117.



MUSCLES OF THE EYEBALL.—1 Fragment of the sphenoid bone. 2. Optic nerve 3. Globe of the eye. 4. Levator palpebræ muscle. 5. Superior oblique muscle. 6. Its cartilaginous pulley. 7. Its reflected tendon. 8. Inferior oblique muscle. 9. Superior rectus muscle. 10. Internal rectus. 11. External rectus. 12. Extremity of the external rectus. 13. Inferior rectus muscle. 14. Sclerotic coat.

The *aqueous humor* is di-

vided by the iris into an *anterior* and a *posterior chamber.* The anterior is the larger. This humor is, as its name indicates, of a watery consistence.

The *crystalline lens* lies behind the posterior chamber of the aqueous humor, and in front of the vitreous humor. It is a double convex transparent body, inclosed in an elastic membranous capsule. It measures about one-third of an inch across, and one-fourth of an inch from before backwards. The posterior surface is the most convex. In structure, the lens is formed of a number of concentric laminæ, which may be separated by boiling or immersion in alcohol. By the same means a partition of the lens may be shown into three triangular *segments.* More minutely, the laminæ consist of parallel fibres with wavy margins. The *suspensory ligament* of the lens is a thin membrane between the anterior surface of the lens and the anterior margin of the retina. Posteriorly, this is separated from the hyaloid membrane by a space called the canal of Petit.

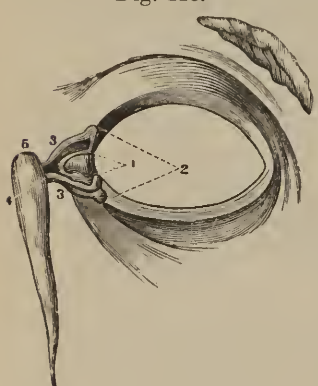
The *vitreous humor* forms about four-fifths of the whole eyeball. It is a transparent jelly-like material, inclosed in the *hyaloid membrane.*

The *arteries* of the eye are the long, short, and anterior ciliary arteries, and the central artery of the retina. The *nerves* of the eye are the optic, long ciliary, and short ciliary nerves.

Appendages of the Eye.

Each *eyelid* (palpebra) is composed of the following structures: skin, connective or cellular tissue, orbicularis oculi muscle, tarsal cartilage, Meibomian glands, and conjunctiva. The *tarsal cartilages* are two thin elongated strips of fibro-cartilage along the margin of the lids. The tensor tarsi muscle is attached to their inner ends. The *Meibomian glands* are about thirty in number for the upper lid; rather less in the lower. They are about as long as the width of the tarsal cartilages. Each has a minute duct opening on the margin of the eyelid.

Fig. 118.



LACHRYMAL CANAL.—1. Puncta lacrymalia. 2. Cul-de-sac at the orbital end of the canal. 3. The course of each canal. 4, 5. The saccus lacrymalis. 6. Ductus ad nasum.

The *eyelashes* are short, thick, curved hairs, in a double, or sometimes triple row on each lid; the convexity of the upper ones being downwards, and of the lower ones upwards.

The *lachrymal gland* lies in a small fossa within the orbit, at its upper and outer, anterior part. It is oval, and about the size of an almond. Six or seven ducts carry tears from it to open through the conjunctiva, over the globe of the eye. Moisture being

thus diffused over the ball, collects near the edges of the lids, and passing between the tarsi in the groove which they make when closed, or along the lower one when open, enters the *puncta lacrymalia*, near the corner of the eye. From these, two minute *canaliculi* convey the secretion (unless when, as in weeping, it is so profuse as to overflow) into the *lachrymal sac*. This is an enlargement at the upper part of the *nasal duct;* which duct or tube lies in a bony canal, three-quarters of an inch long, formed by the lachrymal (os unguis), superior maxillary, and inferior turbinated bones. It opens into the inferior meatus of the nose.

THE EAR.

External Ear.—The expanded part of the ear is the *pinna*, or *auricle;* the auditory opening (and canal) is the *external meatus*.

The *pinna* consists of cartilage covered by skin. Its external prominent rim is the *helix*. Parallel with and in front of this, but dividing above, is the *antihelix*. Within the inclosure of the latter is the cavity of some size, the *concha*. In front of this, over the meatus, is the pointed projection, the *tragus;* and opposite to the latter, a smaller one, the *anti-tragus*. The softer lowest part of the ear is called the *lobule*.

The *external meatus* or auditory canal is about an inch and a quarter long, and directed forwards and inwards, slightly curved. At its end or bottom is the membrana tympani. The meatus is formed partly of cartilage and partly of bone, and is lined with a thin skin. Near the orifice are hairs and sebaceous glands; and, further in, the *ceruminous* glands, which secrete the ear-wax.

Middle ear or tympanum.—Being within the petrous portion of the temporal bone, the cavity of the tympanum is separated from the external meatus by the *membrana tympani*. It communicates with the pharynx by the Eustachian tube. Within it are the *ossicles* or small bones of the ear; *malleus*, *incus*, *orbiculare*, and *stapes*.

Fig. 119.

OSSICLES OF THE EAR.—*a*. Malleus, its head. *h*. Handle of malleus. *b*. Incus. *o*. Orbiculare. *c*. Stapes.

The *malleus* or hammer-bone has a head, neck, handle or *manubrium*, and two processes. The head is the oval upper extremity, which connects with the incus. The manubrium is vertical in position, and is attached along its margin to the membrana tympani. The *processus gracilis* is long and delicate; it gives origin to the laxator tympani muscle. The *processus brevis* or short process gives origin to the tensor tympani muscle.

The *incus* or anvil-bone has an irregular four-sided body, and a long and short process. The body joins with the malleus. The long process connects with the os orbiculare.

The *stapes* or stirrup-bone has very much the shape of a stirrup. By its head it is attached to the orbiculare; by its foot to the

fenestra ovalis of the vestibule. To its neck is connected the stapedius muscle.

The *orbiculare* is a very small round bone, between the long process of the incus and the head of the stapes. These bones are all united by ligaments, admitting of slight movement.

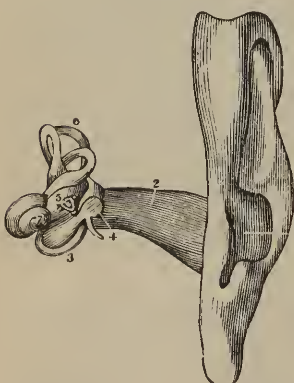
Besides the *fenestra ovalis*, there is another aperture, the *fenestra rotunda*, from the tympanum into the cochlea of the internal ear. The latter is closed by a membrane.

The *muscles* of the tympanum have been already named; *tensor tympani*, *laxator tympani*, and *stapedius*. The first of the three is the largest. It draws the membrana tympani inwards, making it more tense. The *laxator* reverses this action.

The *chorda tympani* nerve leaves the facial to enter the tympanum, and crosses its cavity to an opening near the Glaserian fissure. Several other nerves enter and communicate in the tympanum.

Internal ear, or *labyrinth.*—This is composed of the *vestibule*, *semi-circular canals*, and *cochlea*.

Fig. 120.



VIEW OF THE EAR.—1. The opening into the ear at the bottom of the concha. 2. Meatus auditorius externus. 3. Membrana tympani. 4. Malleus. 5. Stapes. 6. Labyrinth.

The vestibule is the middle portion. On its outer wall are the fenestra ovalis and fenestra rotunda. In its inner wall is the foramen of the *aqueduct of the vestibule*, going to the back part of the petrous portion of the temporal bone. In front is a large opening communicating with the cochlea; *apertura scalæ vestibuli cochleæ*. Behind, five orifices open from the vestibule into the semi-circular canals.

The three *semi-circular canals* are above and behind the vestibule. They are unequal in length and different in direction; two being vertical and one horizontal.

The *cochlea* is shaped somewhat like a snail-shell. It is anterior to the vestibule. It consists of the *modiolus* or *columella*, which is its central axis, and a spiral canal wound around this, with the *lamina spiralis* (partly osseous and partly cartilaginous), contained within the canal. The spiral canal has two turns and a half. The interior is divided into two equal scalæ or staircase-like passages (*scala tympani* and *scala vestibuli*) by the delicate *lamina spiralis;* upon which the nerve filaments of the auditory nerve are spread out. In the substance of the lamina spiralis is the *scala media*, which contains the piano-key-like *rods of Corti.* The terminations of that nerve are also distributed to the vestibule and semi-circular canals.

The whole inner surface of the bony labyrinth is lined by a fibro-serous periosteal tissue. In the vestibule and semi-circular canals, it separates the osseous from the membranous labyrinth;

its fibrous coat being attached to the bone, and its free serous layer to the membranous interior structure. In the cochlea, it covers both surfaces of the osseous zone of the lamina spiralis and then forms the membranous zone (*zona Valsalvæ*), or continuation of the same to the cochlear wall. The *liquor Cotunnii* or *perilymph* is the fluid secreted within the periosteal double layer.

The *membranous labyrinth* is the internal duplicate of the vestibule and semi-circular canals. The vestibular portion of it is formed into two sacs, the *utricle* and the *saccule*. The *endolymph*, or *liquor Scarpæ*, is the fluid contained within the labyrinth. The *otoliths* or *otoconia* are two small round collections of crystals of carbonate of lime, surrounded by fibrous tissue, in the vestibule.

THE NOSE.

Five cartilages, with the bony structures (nasal bones and processes of the superior maxillary bones), make up the framework of this organ; two upper and two lower lateral cartilages, and the nasal *septum*.

Fig. 121.

The Meatuses of the Nose on the Left Side.—1. Frontal bone. 2. Nasal bone. 3. Crista galli of the ethmoid. 4. Cribriform plate of the ethmoid. 5. Part of the sphenoidal sinus. 6. Basilar portion of the sphenoid bone. 7, 7. Palatine process of the superior maxillary bone. 8. [Anterior] nasal spine. 9. Palatine process of the palate bone. *a*. Superior turbinate bone. *b*. Superior meatus. *c*. A probe passed into the posterior ethmoidal cells. *d*. Opening of the sphenoidal sinus into the superior meatus. *e*. Spheno-palatine foramen. *f*. Middle turbinate bone. *g*, *g*. Middle meatus. *h*. A probe passed into the infundibulum leading from the frontal sinus and anterior ethmoidal cells; the triangular aperture immediately above the letter is the opening of the antrum. I. Inferior turbinate bone. *k*, *k*. Inferior meatus. *l*, *l*. A probe passed up the nasal duct. *m*. Internal pterygoid plate. *n*. Its hamular process. *o*. External pterygoid plate. *p*. Root of the pterygoid processes. *q*. Posterior palatine foramina.

The *nasal fossæ* or cavities of the nostrils are lined by the *pituitary* or *Schneiderian* mucous membrane. It is covered by

epithelium, tessellated at the upper part and near the aperture of the nares, but ciliated through most of its extent. The olfactory nerve is distributed to it. Mucous glands abound in it. The passages of the nares or nostrils are divided in front into the *superior*, *middle*, and *inferior meatus*. The *posterior nares* open into the pharynx.

Besides the olfactory, a number of nerves reach the nasal mucous membrane; principally branches of the fifth pair, already described.

CHAPTER XI.

ANATOMY OF HERNIA.

Inguinal Hernia (see Fig. 84).—Dissecting off the skin and superficial fascia from the groin, the lower portion of the *external oblique* muscle is exposed. The diverging fibres of this muscle, just above and outside of the pubes, give passage to the *spermatic cord;* in the female, the round ligament. This natural opening is the *external abdominal ring*. It is, rather, a triangular aperture; the inner column of which is that part of the tendon of the muscle which goes to the symphysis pubis; and its outer column, a portion or reflection of *Poupart's ligament; i. e.*, the tendinous margin of the external oblique muscle, extending from the anterior superior spine of the ilium to the pubes. *Direct* or *ventral* hernia occurs immediately through the external ring; carrying over it the common tendon of the internal oblique and transversalis.

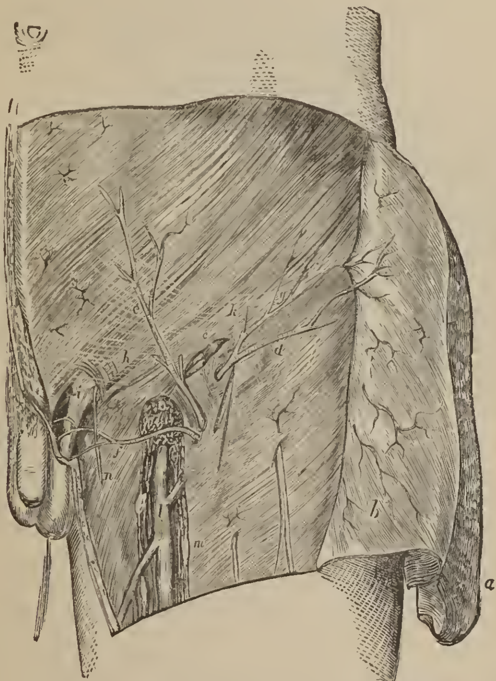
The *inguinal canal* leads from the external ring, downwards, forwards, and inwards, about an inch and three-fourths, to the *internal* abdominal ring. Along it the spermatic cord passes to and through the *internal* abdominal ring. This is an opening in the *fascia transversalis* through which the cord enters, or, as properly, *emerges* from the abdomen, on its course to the testicle.

The fascia gives a fibrous investment to the cord which continues to the testis; this is the *fascia propria*. As the *cremaster muscle* covers the cord, as a "carrying down" of fibres of the internal oblique, a protruding knuckle of intestine, in inguinal hernia, has the following coverings: *skin*, *superficial fascia* (*intercolumnar fascia*, from the external ring), *cremaster muscle*, *fascia propria*, and *peritoneal coat* or *sac*. The epigastric artery lies on the *inside* of oblique hernia, *i. e.*, that through the inguinal canal. In *direct* or *ventral* hernia it is *outside* of the hernial tumor.

Femoral Hernia.—This occurs beneath Poupart's ligament, at the place of transit of the femoral vessels from the groin. Between the vessels and the pubes is a space through which the intestine escapes. It then protrudes further by the *saphenous opening*, by which the internal saphenous vein joins the femoral vein. Over that opening is the *cribriform fascia;* so called from its having a

number of small perforations. The curved margin, by which, at the saphenous opening, the fascia lata of the thigh doubles or dips in, is sometimes called the *falciform border*.

Fig. 122.



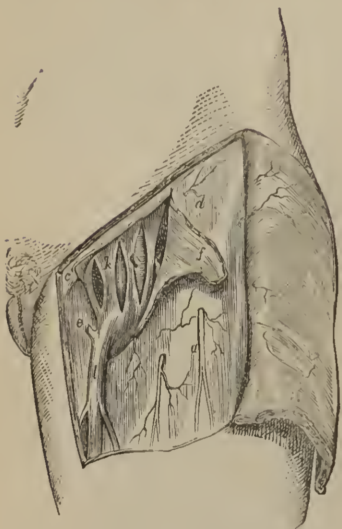
Inguinal and Femoral Regions.—*a*. Superficial layer of [superficial] fascia (reflected). *b*. Deeper layer of [superficial] fascia (reflected) (the superficial vessels being left attached to the external oblique). *c*. Inguinal lymphatic glands. *d*. Superficial circumflex iliac artery. *e*. Superficial epigastric. *f*. Superior external pudic artery. *g*. Poupart's ligament. *h*. Intercolumnar fascia. *i*. External abdominal ring [with the spermatic cord passing through it]. *k*. Arciform fibres of external oblique. *l*. Internal saphena vein. *m*. Femoral lymphatic glands. *n*. Ilio-inguinal nerve. *o*. Saphenous opening.

Scarpa's triangle is the space in the front of the thigh, which contains the upper part of the femoral vessels, the origin of the *profunda* artery and its vein, and the anterior crural nerve.

The *crural arch* is between Poupart's ligament and the pelvis. Under it, besides the iliacus internus and psoas muscles, pass the anterior crural nerve, femoral artery, and femoral vein. To the inner side of the latter is the crural ring.

Gimbernat's ligament is a triangular reflection and expansion of the outer column of the external ring; that is, of the insertion of the external oblique muscle, attached to the *linea pectinea* of the crest of the pubes; and directing a concave border towards the femoral vessels. The part of this border turned most directly to the vessels is *Hey's ligament.* The vessels, as they escape from the pelvis, receive a funnel-shaped fascial envelope—the *crural canal* or sheath of the *femoral vessels.*

Fig. 123.



CRURAL SHEATH LAID OPEN.—*a.* Middle cutaneous nerve. *c.* Placed to inner side of Gimbernat's ligament. *d.* Iliac portion of fascia lata. *e.* Pubic portion of fascia lata. *f.* Margin of saphenous opening (turned back). *k.* Femoral sheath opened by three incisions. *l.* Saphena vein.

A femoral hernia, therefore, has, as its coverings, the *skin, superficial fascia, cribriform fascia, sheath of the vessels* (*septum crurale*, of fibrous tissue from the margin of the crural ring), and *peritoneal sac.*

When, in the descent of the testicle in the process of development, the intestine enters the canal with it, the peritoneum over it not being obliterated, it forms *congenital inguinal hernia.*

Umbilical and other forms of hernia require no special anatomical description here. The student is, however, advised not to be satisfied, in regard to the surgical anatomy of hernia, without repeated *demonstrations* or *dissections.*

CHAPTER XII.

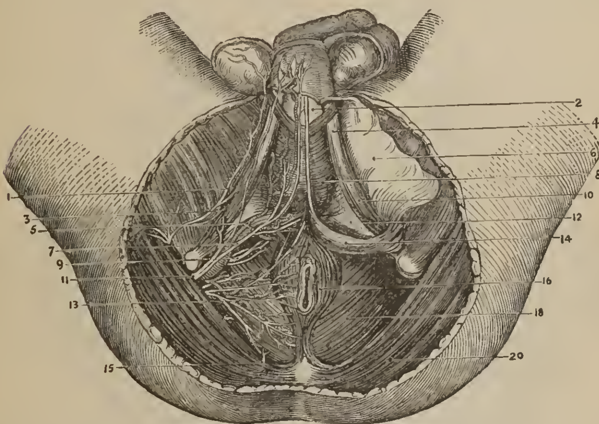
THE PERINEUM.

THIS region lies between the tuberosities of the ischia; with the arch of the pubes in front, and the coccyx behind it. In and beneath the two layers of the superficial perineal fascia, are several vessels and nerves.

The *inferior* or *external hemorrhoidal artery* is a branch of the internal pudic artery, leaving it, behind the tuberosity of the ischium, to go to the levator and sphincter ani.

Further forward, the internal pudic gives off the *superficial perineal* artery. Curving upwards to the ramus of the pubes, it runs obliquely forwards to terminate in the scrotum.

Fig. 124.



MALE PERINEUM.—1. Inferior pudendal nerve. 2. Urethra. 3. External or posterior superficial perineal nerve. 4. Crus penis. 5. Superficial perineal artery. 6. Deep layer of superficial fascia (reflected). 7. Internal or anterior superficial perineal nerve. 8. Accelerator urinæ. 9. Muscular branches of pudic nerve. 10. Erector penis. 11. Internal pudic artery and nerve. 12. Deep perineal fascia or triangular ligament. 13. Inferior hemorrhoidal artery and nerve. 14. Reflection of the deep layer of superficial perineal fascia around transversus perinæi. 15. Branch of fourth sacral nerve. 16. Sphincter ani. 18. Levator ani. 20. Gluteus maximus.

The *transversalis perinei* artery goes off from this at a right angle parallel with the transversus perinei muscle, to the sphincter ani.

The *artery of the bulb* leaves the pudic to enter the corpus spongiosum at its posterior margin. *Sometimes* it is a branch of the superficial perineal artery.

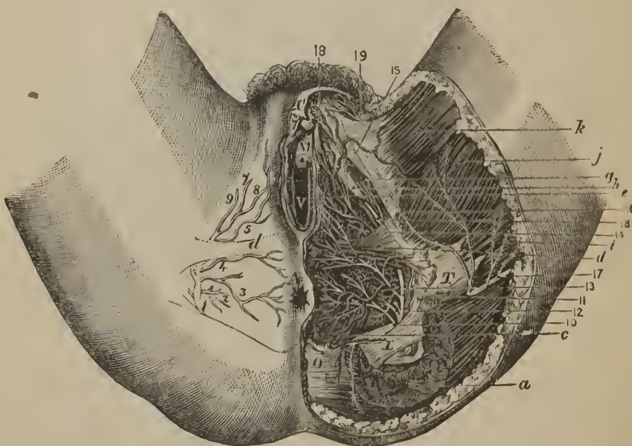
The *internal pudic artery* is an important branch of the internal iliac. It goes out by the great sacro-sciatic foramen, crosses the spine of the ilium, re-enters the pelvis through the lesser sacro-sciatic foramen, and, reaching the ramus of the ischium, an inch in front of its tuberosity, runs beneath its edge to the symphysis pubis. There, as the *arteria dorsalis penis*, it goes on to end at the glans.

Nerves of the perineal region are the internal pudic nerve, perineal cutaneous nerves, and their branches.

Muscles of the same part are, besides the *sphincter* and *levator ani*, the *transversus perinei*, *erector penis*, and *acceleratores urinæ* muscles.

The *transversus perinei* muscle is a small bundle of fibres, passing across from the tuberosity of the ischium to the middle line, when it meets its fellow. The *erector penis* goes from the tuberosity and ramus of the penis. The *acceleratores urinæ* arise from the perineal centre, and by diverging fibres, surround the basal portion of the penis.

Fig. 125.



FEMALE PERINEUM.—1. Pudic artery. 2. Branch to levator ani. 3. Inferior hemorrhoidal artery. 4. Transverse artery. 5. Great labial (superficial perineal) artery. 7. Dorsal artery of clitoris. 8. Artery of bulb. 9. Artery to crus clitoridis. 10. Inferior hemorrhoidal nerve. 11. Pudic nerve. 12. Muscular branch. 13. Internal superficial perineal nerve. 14. External superficial perineal nerve. 15. Its junction with—16. Inferior pudendal nerve. 17. Small sciatic nerve. 18, 18. Dorsal nerve of clitoris. 19. Ilio-inguinal nerve. A. Anus. C. Clitoris. M. Meatus urinarius. L. Great sacro-sciatic ligament. V. Vagina. O. Coccyx. T. Tuberosity of ischium. *a*. Gluteus maximus. *c*. Levator ani. *d*. Superficial transverse muscle. *e*. Compressor bulbi. *g*. Erector clitoridis. *h*. Triangular ligament (cut). *i*. Biceps and semi-tendinosus. *j*. Adductor magnus. *k*. Gracilis.

The *triangular ligament* is a portion of the deep perineal fascia, occupying the space under the arch of the pubes. Between its two layers are Cowper's glands. Through it the membranous portion of the urethra passes. The external pudic arteries and arteries of the bulb are, for part of their course, included within it.

A MANUAL

OF

PHYSIOLOGY.

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PHYSIOLOGY.

DEFINITIONS.

Physiology is the science of the functions of living beings; including, in its widest acceptation, the study of all the changes which they undergo. There may be, therefore, *vegetable* and *animal* physiology; also *human* and *comparative* physiology. *Biology* is a word now much used, meaning the whole science of life. *Pathology* is the physiology of the body and its organs in a state or states of disease; it is fundamental to the scientific practice of medicine.

PART I.

GENERAL PHYSIOLOGY.

This considers the *materials*, *forces*, and *forms* of organized bodies.

CHAPTER I.

ORGANIC MATTER.

The *matter* of which plants and animals are, or have been, composed, is called, from its being or having been present in their *organs* or instrumental parts, *organic matter*. All other substances, with properties not affected by the presence of life, are inorganic. A distinction is perceptible and important between—1st, *organizable* matter; 2d, *organized* material, *i. e.*, that present in living organs; and 3d, that which *has been* organized, but is no more capable of active function or new formation; for the last, the term *post-organic* would be convenient, although it is not usual.

Between the organic and inorganic materials, differences exist—1st, in complexity of composition; 2d, in instability; 3d, in the

forms which they tend to assume, especially under the influence of life. Of the whole number of elements in nature supposed by chemists to be simple or undecomposable, scarcely twenty are found taking part in the composition of plants or animals. In mineral and other inorganic bodies, binary compounds are not rare, and ternary ones common; while, in organic substances, four, five, or a still larger number of elements are more often combined; with, also, a large number of *equivalents* of each. From this complexity of composition results great *instability;* shown by the rapid decay or putrefaction to which vegetable and animal structures are liable after their death. This complexity is greatest in *animal* bodies; most of all in the highest animals.

Carbon, hydrogen, oxygen, and nitrogen are the most nearly universal elements in organic matter. With them occur sulphur, phosphorus, calcium, iron, potassium, sodium, chlorine, silicon, fluorine, and some others, in variable quantities. Animal tissues, except fat (and some very few other partial exceptions among the lowest animals), always have carbon, hydrogen, oxygen, and nitrogen; vegetable substances may consist of the first three of these, without nitrogen; although the latter is also frequently present in plants.

Remembering that *water* is the most abundant of all substances in organized structures, as, for instance, in our own bodies, where it acts as a constituent of both solids and fluids, and as a vehicle of circulation and transmission, we may enumerate the other most important *organizable* proximate (or compound radical) elements, as follows:—

Nitrogenous:

Albumen,	Myosin,
Chondrin,	Globulin,
Ostein,	Casein,
Neurin,	Pulmonin,
Fibrin,	Mucosin.

Also, *pigmentary* or coloring principles, as

Hæmoglobin, of the blood. Melanin, of the skin, iris, hair, etc.

Non-nitrogenous—oleaginous or fatty:

Olein,	Stearin,
Palmitin,[1]	Cerebrin.[2]

Saline substances in the blood furnish some materials for the organization of certain tissues, besides being essential, apparently, to the vital properties of the blood itself. Chlorides of potassium and sodium, and carbonates, phosphates, and sulphates of potassium, sodium and calcium, seem to be the most abundant and important of the salts of the blood.

[1] *Margarin* is now generally regarded as composed of *olein* and *palmitin*.

[2] Liebreich asserts, instead of cerebrin and cerebric acid, the existence in the brain-substance of *protagon;* for which he gives the formula C_{232}, H_{240}, N_4, P, O_{44}. *Lecithin*, also, is found in the brain.

Organic Products.

Unorganizable (post-organic) compound substances found in the blood and in various secretions and excretions, in process of removal from the body, are, chiefly, as follows :—

Nitrogenous :

Ptyalin,	Taurin,
Pepsin,	Taurocholic acid,
Pancreatin,	Glycocholic acid,
Creatin,	Urea,
Creatinin,	Uric acid.

Also, the pigmentary matters of the bile (biliverdin, cholepyrrhin) and urine (urosacin, uroxanthin).

Non-nitrogenous :

Lactin,	Cholesterin,
Lactic acid,	Excretin,
Glycogen,	Stercorin.

Besides a number of *saline* substances (urates, sulphates, phosphates, etc.), found in the urine, bile, perspiration, tears, etc.

The full history of these belongs to organic chemistry. A few words may find place here concerning the *organizable* proximate elements.

Organizable Principles.

Albumen is found in blood and lymph, and though not quite identically one substance, in the white of eggs. Its main peculiarity is its coagulation by heat (below 160° Fahrenheit); it is coagulated also by strong alcohol, tannin, mineral acids, ferrocyanide of potassium in an acid solution, and salts of lead, mercury, and copper.

Chondrin is present in all the hard and elastic tissues of the body; as cartilages, ligaments, tendons, membranes, etc. It is made firm and leathery by tannic acid. Ferrocyanide of potassium does not precipitate it. It appears that the gelatinous constituents of the tissues undergo some alteration in the common process of extraction by long boiling. The fact that pure gelatin, so obtained, is not capable of sustaining life, when used alone as food, is thus explained.

Ostein is the animal matter of bone. It differs in some chemical reactions from cartilage-gelatin (chondrin). Nails and hairs contain *keratin.*

Neurin is a complex substance, presenting two varieties; gray or ash-colored nerve-substance, found in the cellular or vesicular structure of ganglia, and white neurin, of the tubular filaments of nerves and commissures.

Fibrin is the spontaneously coagulable ingredient of the blood. This name is given to it because of its forming, in its coagulation, a fibrillary solidification, imitating a low form of tissue. Schmidt and Kühne deny the existence of fibrin in living blood; asserting it to be formed by a reaction between the colorless corpuscles and a material (paraglobulin) in the serum.

Myosin, or musculin, was long supposed to be identical with fibrin. It differs from the latter in not being dissolved by a solution of nitrate of potassium. It is the special constituent of muscular tissue. *Syntonin* is another derivative of this tissue, under chemical alteration.

Globulin is the substance of the blood-corpuscles; found also in the crystalline lens of the eye.

Casein abounds most in milk, of which it makes about forty parts in a thousand. It is coagulated by feeble acids; as by lactic acid, in the souring of milk. It is highly nutritious. Condensed, it becomes cheese.

Pulmonin is the name sometimes applied to the peculiar substance of lung tissue. Verdeil discovered in this tissue an acid substance, *pneumic acid*, to which importance has been ascribed in the detachment of carbonic acid from the blood in respiration.

Mucosin, of mucus, secreted by mucous membranes, is probably the substance of the membrane slightly altered.

The *pigments* of the blood, skin, iris, and hair contain carbon, hydrogen, oxygen, and nitrogen; sometimes other elements. *Hæmatin*, derived from the red blood-corpuscle, is notable for the amount of its iron (7 per cent.). *Melanin* is a convenient name for the dark coloring matter of solid parts.

Non-nitrogenous tissue-forming substances are the fats; *olein*, *palmitin*, *stearin*, and *cerebrin*. The first three are similar in composition. Each consists of a *fatty acid*, oleic, palmitic, stearic acid, combined with a base (oxide of glyceryl). Stearin is solid up to 130° or 140° Fahr.; margarin (palmitin) melts at about 120°; olein is liquid down to 25°. Human fat consists of palmitin and olein, with very little stearin; deposited in cells. Cerebrin is a more complex substance, found in the brain, associated with phosphorus. Some chemists name, as contained in brain-substance, a nitrogenous acid called cerebric acid, and glycero-phosphoric acid, lecithin, syntonin, olein, cholesterin, etc.

CHAPTER II.

ORGANIC FORCES.

Reason exists for designating by a special name that agency in organized bodies, *i. e.*, plants and animals, which gives them the characters of living beings; and the best name for it is *vital force*, or life-force. *Nerve-force* may, similarly, designate that which is peculiarly the attribute of ganglia and nerves; generated, accumulated, and reflected by ganglia, and transmitted by nerves. Animals only, not plants, possess this.

The ordinary *cosmic* forces (*i. e.*, forces common to all nature), heat, light, electricity, chemical attraction, gravitation, all affect organized beings. They are frequently generated or transformed by vital processes; and have importance in various functions.

The doctrine of the correlation and convertibility of the forces of nature is indispensable, now, in physiology, as it is in physics. By it we mean, that heat, light, electricity, etc., are (not substances, but) different *modes of movement;* and that one kind of motion may be transmuted into another by a change of conditions. This is true of life-force and nerve-force; these being dependent upon heat, light, etc., for their sustenance, and being sometimes, conversely, transmuted into those forces. Of the last change, the luminosity of the fire-fly is probably an example. Some authorities consider that we have no need of the hypothesis of a special vital force; all the phenomena of living beings finding explanation under the ordinary chemical and physical forces, or modes of molecular movement in matter; the same whether organic or inorganic. Even if a merely provisional view, it appears necessary now to designate a certain series of phenomena as peculiar to *life*, just as *other* series of facts and results are referred to *heat*, *light*, etc.

Vital Force.

Life-force ought to be studied, then, like the other forces of nature. By exclusion, we find that, after most functions of the animal or vegetable organs have been explained by reference to chemical, mechanical, or other ordinary physical laws, something is still left. That is, *formation*, *growth*, *development;* the construction, from a formless liquid (blood, sap), of definitely formed structures, going through a series of changes for a definite period. We call the cause of this adaptive formation and change *life*. When it ceases, *death* is characterized by the loss of all that was peculiar to the being, and the return of its materials to the inorganic (through the post-organic) state.

We may enumerate the main facts established concerning vital force, as follows: 1. It is common to *animals* and *plants*. 2. It never originates except from parentage; *omne vivum ex vivo.*[1] 3. Its action is essentially *formative* and *reparative*. 4. In the living body, it *controls* and *directs* the other physical forces, as chemical affinity, etc., modifying their results. 5. It acts *expansively*, from centres outwards; as shown by the production of rounded forms, cells, etc.[2] 6. Sometimes it may be *transmuted* into other forces during life, and is altogether so at death. 7. Other forces, *especially heat*, *sustain* it, or are converted into it. 8. Sometimes it may be *suspended* for a time; as in the winter torpor of certain animals. 9. It is always *definitely limited* in duration under any particular form; that is, each individual can live only for a certain time, longer or shorter, according to its species. 10. Life-force may *vary in degree*, in the same body at different times, and in the different parts of the same organism. This last proposition affords the best foundation for rational pathology. Yet it would be a serious error to suppose that *all* disease consists merely in diminished vitality, general or local.

[1] This opinion prevails amongst physiologists, although warmly disputed by Pouchet, Bastian, and others.

[2] It is not certain, however, that the expansion occurring during cell-growth may not be due to *heat;* the life-force acting in *limitation* of it.

CHAPTER III.

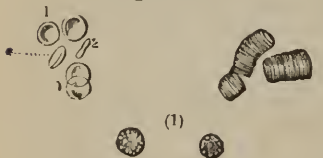
ORGANIC FORMS.

LIQUIDS and solids together make up every organized body which has active functions. The liquids in plants are the sap, and sometimes special juices; in animals, the *blood*, *lymph*, *chyle*, and various secretions. The solids are the *organs*, composed of various *tissues;* and these, of elementary forms, viz., *molecules*, *nuclei*, *cells*, *fibres*, *membranes*, *tubes*.

The Blood.

As seen under the microscope, the blood consists of a colorless liquid (liquor sanguinis) in which float the red and the white or colorless corpuscles; from fifty to five hundred of the red, to one of the colorless in human blood. Of the former, the diameter is about $\frac{1}{3500}$th of an inch; of the white corpuscles, $\frac{1}{2500}$th. The latter are nucleated; the red corpuscles in man are not. The shape of the red corpuscles is disk-like or car-wheel-like; *i. e.*, circular, flattened, and concave at the middle. Carbonic acid and some other gases, when absorbed, swell the corpuscles into a more globular form; oxygen widens and flattens them. The difference in color between arterial (oxygenated) and venous blood has been, by some, ascribed to this change of shape. The biconcave corpuscles concentrate the light which they reflect, giving a brilliant effect; while the diffusion of rays reflected from the more convex surfaces of the corpuscles of venous blood produces a dull purple color. Another more probable view is, that blood-corpuscles contain a special principle, *cruorin*, the color of which is altered by the absorption and loss of oxygen.

Fig. 126.



BLOOD-CORPUSCLES.

The question whether the blood-corpuscles are true *cells*, with a cell-wall containing liquid, or only minute semi-solid masses of material, has been much debated. Probably the latter view is correct. The colorless corpuscles (often called *leucocytes*), when placed in water or a dilute saline solution at the temperature of the body, undergo spontaneous movements and changes of form, called *amœboid*, from their resemblance to those of the microscopic protozoon *amœba*. The importance of the leucocytes in nutrition, inflammation, and the formation of tumors, is more highly estimated by many physiologists now than formerly. Their escape

from the capillary vessels, under some circumstances, has been observed by Waller, Recklinghausen, Cohnheim, and others.

Human blood has a salt taste, a peculiar odor, alkaline reaction to test paper, and, while in the living bloodvessels, a temperature of 100°. When drawn from the body, in about ten minutes it begins to *coagulate* or clot; the total separation of the coagulum from the liquor *serum* taking place gradually, and requiring many hours. In the *clot* is the fibrin of the blood, and its corpuscles; in the *serum*, albumen, the salts, and water. A *buffy coat* is sometimes seen on the surface of the clot, when the red corpuscles sink with unusual rapidity. In like cases, as of inflammatory disease, the coagulum may present a *cupped* top.

Fig. 127.

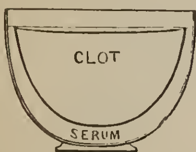
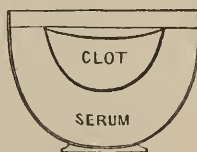


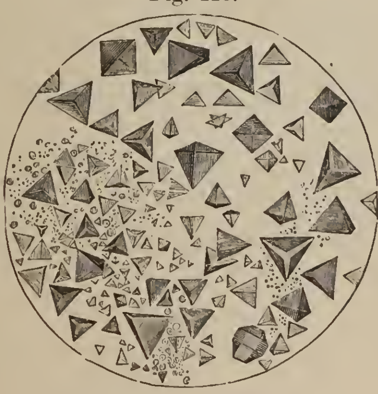
Fig. 128.



BLOOD COAGULA.

The cause of the coagulation of blood out of the body, or even within it if the circulation be arrested (as within the sac of an aneurism) is not known, further than that it depends upon the presence of fibrin. Richardson's theory, that it is owing to the escape of

Fig. 129.



BLOOD-CRYSTALS (GUINEA-PIG).

ammonia, whose presence in the blood keeps the fibrin liquid, is open to many objections, and has now been abandoned by its proposer. Lister's theory, that the coagulation of the blood depends on contact with foreign matter, is clearly insufficient. Another

view is, that *vitality* maintains the fluidity of the fibrin of the blood, and that when dead it becomes solid; as heat makes many things liquid, which congeal when they cool. The analogy is legitimate. Kühne, Schmidt, and others, do not admit that fibrin is present in healthy living blood. They assert that it is formed by mutual reaction between the globulin or *fibrinoplastin* of the colorless corpuscles, and *paraglobulin* or *fibrinogen*, an ingredient of the serum. This view has met with much favor.

Fig. 130.

Crystals from Human Blood.

Coagulation is retarded by cold, and favored by rest, free access of air, and the multiplication of points of contact. In the act of death, or shortly before it, clots sometimes form in the heart and obstruct its valves. When blood has been at rest for a considerable time, *blood-crystals*, of hæmatoidin or hæmato-crystallin, often form in it, of various shapes.

The *amount* of blood in a human body is not exactly ascertainable. It may be estimated at from fifteen to twenty pounds. Its *composition* is given by Dr. Kirkes, on the basis of numerous analyses by different observers, as follows :—

Average proportions of principal constituents in 1000 parts :—

Water	784
Red corpuscles	130
Albumen	70
Saline matters	6.03
Extractive and fatty matters	7.77
Fibrin	2.2
	1000.00

It is remarkable that the blood never contains any gelatin. Its potassium is contained chiefly in the corpuscles; chloride of sodium in the liquor sanguinis or plasma.

Average proportions of all the constituents of the blood in 1000 parts :—

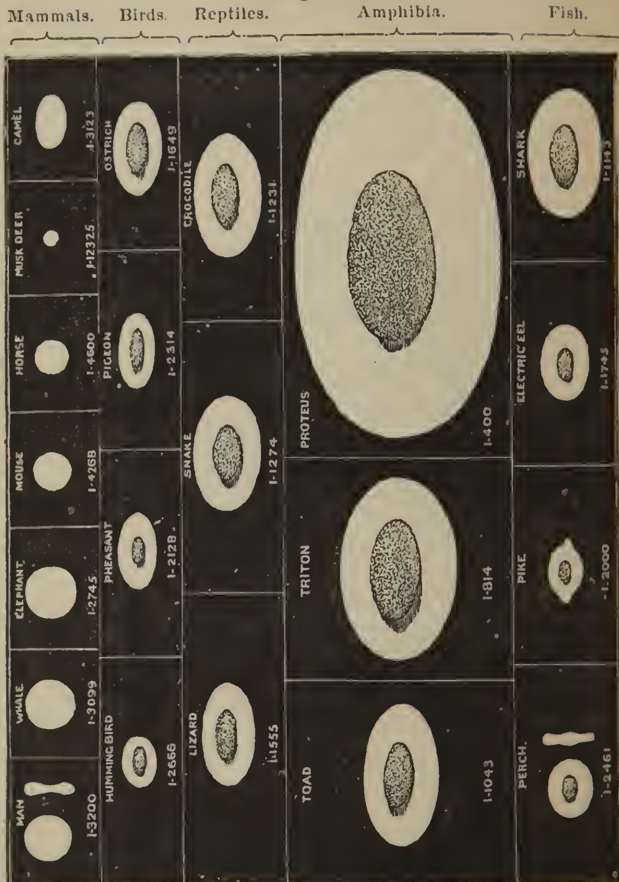
Water		784
Albumen		70
Fibrin		2.2
Red corpuscles :—		
globulin		123 5
hæmoglobin		7.5
Fatty matter :—		
cholesterin	0.08	1.3
cerebrin	0 4	
serolin	0.02	
oleic and palmitic acids		
volatile and odorous fatty acids		
fat containing phosphorus		
Inorganic salts :—		
chloride of sodium		3.6
chloride of potassium		0.36
tribasic phosphate of sodium		0.2
carbonate of sodium		0.84
sulphate of sodium		0.28
phosphates of calcium and magnesium		0.25
oxide and phosphate of iron		0.5
Extractive matter, with salivary matter, urea, creatin, creatinin, lactic acid, biliary coloring matter, gases, and accidental substances		5.47
		1000.00

The *gases* of the blood are, ordinarily, oxygen, nitrogen, and carbonic acid gas.

The *development* of the blood is an obscure subject. There appear to be two sets of blood-corpuscles ; the first peculiar to fœtal life, originating as primary cells in the *vascular layer* of the embryo ; the others afterwards, in modes not demonstrated. Probably they, as well as the *plasma* or liquor sanguinis, are formed of materials furnished, and vital influence supplied, by the mesenteric glands to the chyle which passes through them. Chyle corpuscles and lymph corpuscles are, in appearance, identical with the colorless corpuscles of the blood. Whether the red blood-corpuscles result from modification of these, or are generated independently, has not yet been rendered certain. Many physiologists believe the *nuclei* of the leucocytes to be developed into red corpuscles.

The *uses* of the blood are, to give nourishment and vital stimulation to all parts of the body ; nutrition by the material which transudes from its plasma through the walls of the capillaries, and stimulation also by the oxygen it conveys. It is likely that the red corpuscles are the principal oxygen carriers, and that the carbonic acid is mainly absorbed by the liquid part (whose salts facilitate its absorption), but partly by the corpuscles. The constant movement of properly aërated blood is essential to life ; and its momentary failure is made known by the cessation of functional activity in the great organs. Thus it is in *syncope*, or fainting ; when the heart ceases to send fresh blood to the brain, unconsciousness results.

Fig. 131.



TYPICAL CHARACTERS OF THE RED BLOOD-CELLS IN THE MAIN DIVISIONS OF THE VERTEBRATA.—The fractions are those of an inch, and represent the average diameter. In the case of the oval cells, only the long diameter is here given.

Chyle.

This is the fluid taken up by the *lacteals* or absorbent vessels of the small intestine. After digestion of food it is milky in character, from the amount of oily matter it contains (lacteals, from *lac*, milk). Passing through the mesenteric glands, the amount of fibrin and of colorless corpuscles and molecules increases. All

the lacteals empty into the thoracic duct; and this terminates at the junction of the left subclavian and internal jugular vein, in the upper part of the left side of the thorax or chest. The obvious purpose of the chyle is to replenish the blood with nutritious, especially fatty, material.

Lymph.

The *lymphatics*, or common absorbents, take up this, as the effused or transuded plasma of the blood, in different parts of the body, not all consumed. Almost all organs of the body have lymphatic vessels permeating their substance. These vessels all pass through lymphatic *glands*, whose precise action is not understood. *Assimilation* is probably their function; that is, preparing their contained fluid for use in nutrition, by rendering it more like the tissues. This function is believed to be shared by the liver, spleen, and, in very early life, the thymus and thyroid glands.

Elementary Solid Forms.

These are *molecules*, *cells*, *nuclei*, *fibres*, *membranes*, and *tubes*. All of them are rounded; none angular. This is an important difference between *organic* and *inorganic* forms; the latter being very often angular. A crystal is a typical example of the inorganic; a cell of organic form.

Fig. 132.

NUCLEATED CELLS.—*a*. Blood-corpuscles. *b*. Nerve cells. *c*. Cartilage cells. *d*. Connective tissue cells. *e*. Elastic fibre cells. *f*. Pigment cells. *g*. Muscular fibres. *h*. Capillary vessels.

The importance of the cell in morphology (science of forms), vegetable and animal, is very great. Prominent in physiology and pathology, from Schleiden and Schwann (the first cell-discoverers, 1836–38) to Virchow, has been the cell-theory; according to which *all* activity, for development and functional performance, belongs to cells only. *Omnis cellula e cellulâ* is Virchow's maxim, in his *Cellular Pathology*.

The first clear recognition of the *nucleus* was made by Robert Brown, 1833. Raspail studied the *reproduction* of cells about 1837. Henle pointed out (1841) three modes of cell-multiplication: 1,

budding; 2, *endogenous* cell-formation (cell within cell); 3, *segmentation*, or cell-growth by *division* of mother-cells. Barry and Goodsir added the observation of the *division of the nucleus* in cell-multiplication.

Protoplasm (Remak, Von Mohl, Max Schultze) is the semi-fluid matter contained in animal and vegetable cells; when living, called *bioplasm* by Beale. In living organisms, it contains granules which are seen by aid of the microscope (as in the sting of the nettle) to be in constant regular movement. Chemically, the composition of this fundamental substance in plants and the different classes of animals is *similar*, but not identical.

Cell-walls have been shown (Leydig and Schultze) not to be indispensable; an organic cell has (1856–61) been defined as *a mass of protoplasm surrounding a nucleus.* Yet Hæckel, Stricker, and others have shown that all cellular functions may be performed by *non-nucleated* cells. The essential property of these "physiological units" appears then to be, merely, a certain individuality, with the endowment of vitality.

All physiologists do not admit the *exclusive* activity of cells. Dr. Beale asserts two states of organic matter, in the tissues and organs of the living body; *germinal* matter (mostly, but not universally or necessarily, contained in cells), and *formed* material, which has changed from the active to the passive state, from which it becomes effete and excrementitious. The latter is usually furthest from the central and more vital portions of cells or other forms.

Dr. J. H. Bennett advocates *molecular* physiology; believing that activity for development and function resides in the *molecules* or particles, within or without organic cells and other formative elements. Probably there is some truth in all these views; while each is too exclusive. Life is probably the endowment of the whole germ from which the organism is evolved; and pervades all parts, though not with equal intensity or degree, according to their uses and functions.

Organic Cells.

Cells are, when first originated, nearly globular (spheroid) in shape. Mutual compression often makes them polygonal (many-sided), and especially hexagonal (six-sided). By development and transmutation, some cells are converted into fibres, and others into tubes. Some remain as cells until disintegrated and destroyed.

Fig. 133.

PAVEMENT EPITHELIUM.

Some, as blood cells, chyle and lymph corpuscles, and spermatozoa, float or move in liquids. Others become fixed as parts of firm tissues; as, for example, those of which the prismatic columns of tooth-enamel are constructed.

In connection with membranes, there is a variety in the forms of cells, often arranged in layers. Three kinds of epithelial or pavement-cells are found: *tessellated*, *cylindrical*, and *ciliated* epithelium. The

first are rounded at first but become flattened and polygonal. They exist in the cuticle or scarf-skin, conjunctiva of the eye, the mouth, pharynx, œsophagus, vagina, serous and synovial membranes, many gland-ducts, bloodvessels, and lymphatics. *Cylindrical* or *conical* epithelial cells are found, from the cardiac orifice of the stomach along the alimentary canal to the anus, and lining the gland-ducts communicating with the stomach and intestines; also, in the greater portion of the male urino-genital apparatus, and in the female urinary passages. *Ciliated* cells are so called from the presence on their summits of extremely minute *cilia*, or lash-like processes; which, during life, and for a time after death, are incessantly in waving motion; compared, when viewed under a microscope, to the undulations of a field of grain in the wind. The result of their movement is usually to produce a current (in a tube, for example) in one direction. Such cells are found in the human body, lining the nasal cavity, except the strictly olfactory portion; in the frontal sinuses, lachrymal canal, and mucous surface of the lids of the eye; the upper part of the pharynx, soft palate, Eustachian tube, and middle ear or tympanum; all the respiratory tract, from the glottis to the terminating ramules of the bronchial tubes; in the epididymis of the testicle; and in the female generative organs, from the neck of the uterus to the fimbriated extremities of the Fallopian tube.

Fig. 134.

CILIATED EPITHELIUM.

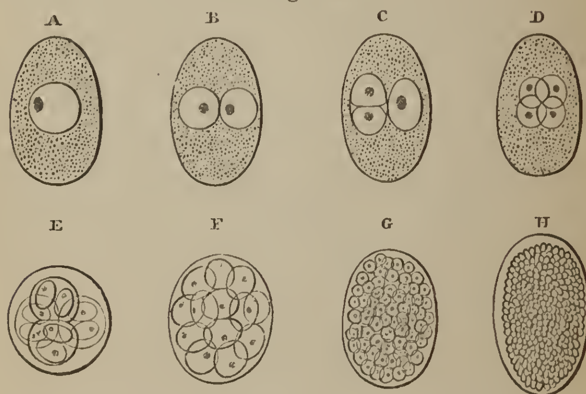
Powers ascribed to organic cells, under different circumstances, are various. 1. *Selection.*—Each cell has capacity to select and absorb from the common reservoir, the blood, just such materials as are appropriate to its place and action; fat in the adipose tissue, neurin in the ganglia, urea in the kidney, etc. 2. *Elaboration.*—Some cells only possess this power, to modify or elaborate material selected. Thus, in the liver, bile is partly a product of such an action in the cells of the organ; and so is milk in those of the mammary gland. 3. *Simple absorption* is effected by some cells, as those which cover the *villi* or minute projecting tufts of the lacteals, through which chyle is taken up from the small intestine. 4. *Elimination*, or secretion and excretion, is performed by others; as those of the kidney, sweat-glands, etc. 5. *Aeration* of the blood is accomplished by the vesicles of the lungs; which, however, are larger than ordinary cells, so called. 6. *Conveyance of oxygen* is attributed to the red cells or corpuscles of the blood. Most micrologists now deny the character of true cells, with a cell wall, to these corpuscles. 7. *Change of form*, producing linear *contraction*, belongs exclusively as a function to muscle cells. 8. *Sensation*, *thought*, and *emotion*, so far as they are physiologically related, have for their instruments gray nerve-cells in the brain. 9. Lastly, cells may *reproduce* other cells—by subdivision or proliferation, *i. e.*, new cells being formed from them.

Most cells are *nucleated;* that is, have within the cell wall a more minute body, often itself cellular. The action of chemical

20

substances, as acetic acid, is not the same upon the cell-wall and the nucleus. The latter grows darker and more distinct under acetic acid. The nucleus is, also, more readily than the cell-wall, stained with an ammoniacal solution of carmine. Cells may contain several nuclei. Sometimes nuclei become separately developed. The *contents* of different cells vary much more than their walls; but the *causes* of their selective and other peculiar powers are beyond special explanation. A plausible supposition as to the origination of some cells has been founded upon an experiment of Ascherson; viz., on dropping very small drops of oil into a solution of albumen, each droplet surrounds itself with an albuminous pellicle or covering, resembling closely an organic cell.

Fig. 135.



Multiplication of Cells.

Partial explanation, only, of the transmission of fluids through cells and other elements of tissue, is found in *osmosis*, or endosmosis and exosmosis. These terms are applied to the transition of fluids through animal membranes; so that, two different fluids being on opposite sides of a membrane, an exchange takes place between the two. For example, if a fresh piece of membrane be stretched between a solution of salt and a quantity of pure water, after a while the solution will become more dilute, and the water on the other side will taste of salt. *More* of the pure water, however, has passed through, so that the quantity of the salt solution is increased, and that on the other side is lessened. The more abundant imbibition is called *endosmosis;* the lesser, *exosmosis.* Instead of salt, sugar, gum, albumen, etc., may be employed.

Conditions affecting osmosis are, 1. The freshness of the membrane. 2. Extent of contact between it and the liquids. The greater this is, the more rapid the flow. 3. The nature of the materials used. Dutrochet found that, through ox-bladder, water would pass into a solution of albumen or of sugar with a force

more than twice as great as into one of gum, and three times as great as into a solution of gelatin. 4. The position of the membrane; *e. g.*, with mucous membrane, as to which of the liquids the mucous surface is presented. 5. Temperature. Endosmosis is most active at a moderately elevated heat. 6. Pressure affects it considerably. The greater the pressure, other things being equal, the more rapid the imbibition.

Sometimes, as when water and albumen are used, endosmosis occurs without any returning exosmosis. Generally, the stronger current is from the less dense to the more dense liquid. In the case of alcohol and water, it is, as an exception, the reverse. It appears that the force of osmosis does not depend upon the degree of attraction of the liquids for each other, but upon the attraction of the membrane for the liquids, by which it takes them into, and passes them through its substance. The movement of a fluid in a continuous current, as it occurs constantly, during life, always favors endosmosis. So does the extent of contact produced by the minute ramification of the capillaries. *Albumen*, under ordinary circumstances, as already stated or implied, is not capable of endosmosis or exosmosis itself, though water will endosmose into it.

Dialysis is a name given by Graham to the process of transition of materials in solution through a permeable septum, by which substances mixed together may become separated from each other. He distinguishes bodies into *colloids* and *crystalloids;* the former, comprising organic matters and a few inorganic ones, not passing through a membrane used as a *dialyser*, while crystalloids do freely. Saline substances and sugar are crystalloids; albumen, gelatin, starch, hydrate of aluminium, and hydrated silicic acid, are examples of colloid substances. This difference of diffusibility no doubt has its influence in the living body, although its bearings are not yet fully discerned.

Fibres and Membranes.

It is almost certain that *fibres* are *directly* organized from plasma, in the white fibrous and yellow elastic tissues. Of simple *membranes* so formed, probably the only examples are, the capsule of the lens of the eye, the layer at the back of the cornea, and the "basement membranes" of mucous tissue, upon which cell-layers are formed.

Tissues.

As all the tissues are compounded of the few elementary forms already mentioned, with more or less modification of the contents of cells and tubes, and of structureless intervening substance, their classification must be somewhat arbitrary. The clearest and most convenient arrangement of them is the following:—

Connective,	Corneous,
Fibrous,	Fatty,
Elastic,	Mucous,
Cartilaginous,	Serous,
Osseous,	Muscular,
Dermoid,	Nervous.

To these might be added, perhaps, *tubular* tissue; that of the capillary bloodvessels, lacteals, and lymphatics.

Connective tissue is also called areolar or cellular tissue. It is the most abundant of all, and is the *packing* tissue of the body; being placed between muscular fibres and nearly all other contiguous yet separable parts. Its structure is essentially fibro-cellular. Connective-tissue *corpuscles* (irregularly stellated) are recognized in it by Virchow and others.

Fibrous tissue is white, tough, and flexible. It exists in ligaments, tendons, periosteum, and certain membranes, as the dura mater of the brain, and the outer layer of the pericardium; and in the outer coat of the arteries.

Elastic tissue is yellowish in color, and microscopically more *tangled* in structure than the white fibrous tissue. Some of the ligaments of the spinal column possess it, and it is united with muscular tissue in the middle coat of arteries. It contains *elastin*, which differs somewhat from gelatin.

Fig. 136.

White Fibrous Tissue.

Fig. 137.

Yellow Fibrous Tissue.

Cartilage is met with in many places in the body; between the vertebræ of the spine, between the ends of bones, at the joints connecting the ribs with the sternum, making the flexible portions of the nose and ears, and the edges of the eyelids. It is also the basis of formation of the bones. Cartilages may, therefore, be classified as *temporary* and *permanent*. The latter are sometimes subdivided into the *cellular*, *hyaline*, and *fibrous* cartilages.

Osseous or bony tissue is compounded of ostein or bone-cartilage and mineral matter, chiefly phosphate of calcium (see *Anatomy*). A modification of it is seen in the *dentine* of the teeth; which also present two other peculiar substances, the *cementum* which covers the fangs, and *enamel*, the covering of the crowns of the teeth.

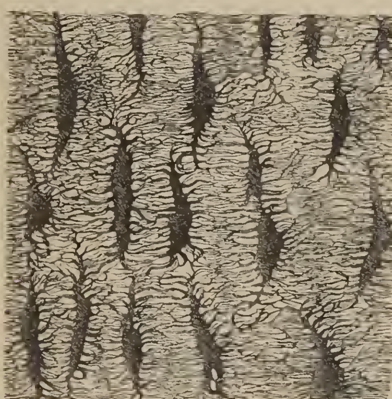
Dermoid tissue, or skin, is intermediate between, or composed of, fibrous and areolar or connective tissue (see *Anatomy*).

Fig. 138.

FIBROUS CARTILAGE. FROM THE SYMPHYSIS PUBIS. MAGNIFIED.

Corneous or horny tissue is represented in man by the nails; the hairs are not far removed from it, although of a somewhat special tubular structure.

Fig. 139.



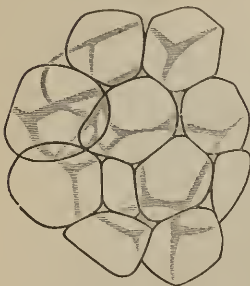
OSSEOUS TISSUE.

Fatty tissue is formed by the distribution of drops of semi-fluid oleaginous matter in cellular spaces of connective tissue. Fat lies under the skin, and gives roundness to the face, trunk, and limbs; besides furnishing cushions to prevent pressure on other parts, and, by its non-conducting power, to protect the body from undue loss of heat. Cushions of fatty deposit are also found behind the eye-ball, around the heart, kidneys, and other parts. Fat is absorbed when waste of the body exceeds the supply of food; seeming to afford fuel for the "combustion" which generates animal heat.

Mucous tissue lines all those cavities of the body which commu-

nicate with the exterior; the orbit of the eye, the mouth, nostrils, throat, alimentary canal, bladder, vagina, uterus, etc. It consists of a basement membrane, on which is a layer of epithelial cells, already described.

Fig. 140.



FAT VESICLES.

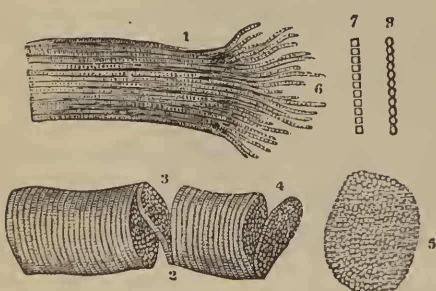
Serous tissue *envelops* the organs contained in the great cavities of the body; as the lungs, abdominal organs, etc. It is, in those situations, always *double*, to lessen friction. It is thin, and very smooth, covered with epithelium, and moistened with serum or serosity.

Glandular structure is not identical in all the glands; but in each consists of *cells*, clustered or conglomerated together variously. The differences belong to descriptive anatomy.

Parenchymatous tissue is spoken of as existing in the liver, kidneys, lungs, and other large organs. The analogy between the lungs and secreting glands is close; but the air vesicles are larger, and open freely into the bronchial ramifications.

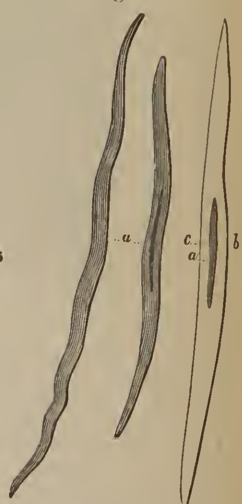
Muscular tissue is of two kinds. That of the voluntary muscles (of locomotion, etc.) is red, and composed of *fibres;* each fibre of *fibrils*, and, as shown by the microscope, each of these of *cells*, (sarcous elements) end to end.[1] *Striæ* or circular marks indicate

Fig. 141.



STRIPED MUSCLE.—1. Longitudinal cleavage. 2, 3, 4. Transverse cleavage. 5. A detached disk. 7, 8. Separate fibrillæ.

Fig. 142.



SMOOTH MUSCLE.

the line of separation between the cells of the fibrillæ of a fibre, bound in its sheath or *sarcolemma*. The contraction of this red, striped or striated muscular tissue, occurring by the widening and shortening of the fibrillary cells, is quick,

[1] The truly cellular nature of these minute muscular elements is now denied by several physiologists.

limited, and short in duration. In the heart only is this striped tissue altogether beyond the influence of the will; although it is almost entirely involuntary in the pharynx except at its upper part,

Fig. 143.

NERVE CELLS.

and is rather controlled by emotion than by will in the muscles of expression in the face.

The other muscular tissue is pale or white, and non-striated; it is formed of spindle-shaped fibre-cells, overlapping each other; very often in bands rather than in bundles. It is always involuntary. Examples of it are in the muscular coat of the stomach and intestines, tunica dartos of the testicle, and in that of the bladder; the uterus, especially during pregnancy; in the gland ducts, and the middle coat of arteries.

Nervous tissue is also of two principal kinds; the *gray vesicular* and the *white tubular;* the first in the ganglia, spinal mar-

Fig. 144.

NERVE FILAMENTS.—A. Diagram of nerve-tubule. *a.* Axis cylinder. *b.* Inner border of white substance. *c, c.* Outer border of same. *d, d.* Tubular membrane. B. Tubular fibres. *e.* In natural state. *f.* Under pressure. *g, g′.* Varicose fibres.

row, and brain, though not constituting the whole of these. The first, formed of nucleated nerve-cells, many of them with processes (bi-polar, multi-polar), is active, cumulative, or reflective in function; the other, white tubular matter of the nerves and commissures, is simply capable of transmission and communication. Some of the nerves, especially of the "sympathetic" or ganglionic system, are gray and gelatinous; but still unlike the gray or cineritious nerve-tissue of the ganglionic centres. The substance of all the nerves is very soft, when examined soon after death. Minute examination shows a difference between the central part of the nerve-filament (*axis-cylinder*) and the medullary matter around it, often called the *white substance of Schwann*. This latter appears to be absent or deficient in the branches of the olfactory nerve, and in most of the nerves of the ganglionic system.

CHAPTER IV.

ORGANIC FUNCTIONS.

Two classes of functions (meaning by function action, operation) are performed by organs or apparatus in the animal body. One class is of actions common, in nature though not in method, to plants and animals. These are the functions connected with the *nutrition* of the organism; *organic* or *vegetative* functions. Such are absorption, assimilation, circulation of fluid, aeration, secretion, and reproduction. Others are entirely peculiar to animals; as sensation and spontaneous locomotion. These are *animal* functions, or functions of *relation*.

Comparison of Animals and Plants.

The differences between animals and plants are several. Plants are without most of the organs which the movements and endowments of animals require, as the stomach, liver, heart, etc. The *chemical composition* of the tissues of plants is simpler. Plants require *inorganic* matter for their *food;* as, carbonic acid, ammonia, potassa, etc.; animals must have *organic* matter; as, what we call our vegetable and animal food. Plants may thus be said to *prepare* organizable material for animals. Animals *elaborate* it further for their own substance, and then, by various actions, *restore* it again to the inorganic world. Water, though an inorganic substance, is a common vehicle for both. So, we find *water*, *carbonic acid*, and *ammonia* to be typical inorganic materials absorbed by plants through their leaves and roots, to be assimilated in the sap, and organized into stem, leaves, flowers, etc. Again, water, carbonic acid, and ammonia are common and representative results of life-processes in animals, *after* organization has made them effete and thrown them out in excretions and exhalations.

Animals and plants both require *aeration*. But their action upon the air is different, even opposite. During the daytime,

plants absorb carbonic acid from the air, and give out oxygen. Animals absorb oxygen, and return carbonic acid.

Sensation and locomotion are altogether animal functions. Yet apparent exceptions to this exist; as, in the shrinking of the sensitive plant when touched, the closing together of the leaflets or lobes at the extremity of the leaf of the Venus' fly-trap, rhythmic movements of the stems of plants called oscillatoriæ, and actual locomotion of the zoospores (germinative seed-like particles) of Algæ. These are difficult of precise explanation; but it is evident that they are not exactly the same as the sensibility and truly spontaneous locomotion and other varied movements of animals. In their lowest and simplest forms, animals and plants approach each other very closely; so much so that doubt exists, in certain instances, to which kingdom to refer some of them. Some naturalists (Cassin, Wilson, and Hæckel) have proposed, therefore, a third intermediate kingdom of *primalia*, or *protista*.

The *animal* functions, sensation and spontaneous motion, are called functions of *relation*, because they bring the body into relation with the external world, and its own different parts with each other.

Man, as an animal, resembles in general structure the other animals of the class *Mammalia*, *i. e.*, those who suckle their young.

Fig. 145.

Hand of Man and of Orang.

But he has some peculiarities, which, apart from his higher mental and spiritual endowments, separate him, even, from the apes and other *quadrumana*, which resemble him most. These are, in brief, the erect posture, curves of the spine, width and capacity of the pelvis, depth of the socket of the hip-joint, long legs and short arms, wide and strong knee-joint, firmly arched foot, backward-projecting heel, prominent chin, even rows of teeth, absence of intermaxillary bone in the upper jaw in the mature skeleton, head balanced *equally* upon the spine, large head and brain, speech, laughter, and tears.

PART II.

SPECIAL OR FUNCTIONAL PHYSIOLOGY.

CHAPTER I.

ALIMENTATION.

THIS comprehends, after *prehension*, or the taking of food, *mastication*, *insalivation*, *deglutition*, *digestion*, *absorption*, *assimilation*, and, as the final result of all, *nutrition*.

Mastication and Insalivation.

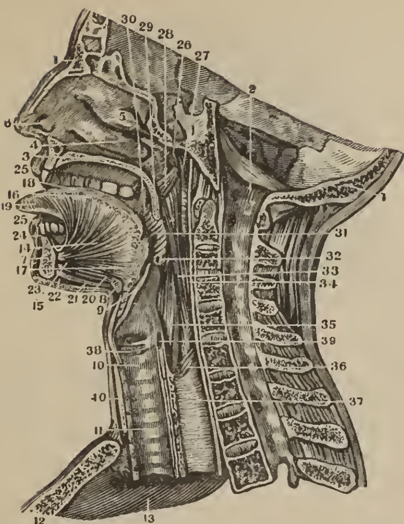
These are accomplished together; by the muscles of the jaws, which make the teeth divide the food, acting at the same time with those of the tongue, to mix the saliva with it. The temporal, masseter, and pterygoid muscles are chiefly used in mastication.

The *salivary glands* are the *parotid*, *submaxillary*, and *sublingual*. Different opinions exist as to the respective actions of their secretions. The *mucus* of the mouth, from numerous follicles, is added to them in mastication. It seems to be shown, that the mixed fluid will, out of the body, act upon starch, converting it first into dextrin, and then into sugar. Several experimenters have found saliva from the different glands to act in the same manner. As this effect is prevented by the presence of acid, it appears to be entirely arrested in the stomach. Dr. Dalton concludes that the saliva does not, therefore, digest starch; but that its solution is effected in the small intestine by the pancreatic juice. Dr. A. Flint, Jr., asserts the more generally held opinion, that at least a considerable part of the starch of food is changed into sugar by the saliva. This fluid is peculiar in containing, though not invariably, *sulpho-cyanogen*. Its active principle, ptyalin, or salivin, is a nitrogenous substance, analogous in composition and catalytic agency, to *diastase* of the seeds of plants; by which the change from starch to sugar is effected at a certain stage of germinal development.

Deglutition.

When the "bolus" of masticated food is forced by the muscles of the tongue and palate through the fauces and over the epiglottis into the pharynx, the constrictor muscles of the latter carry it downward; the contraction of the œsophagus upon it conveys it through the cardiac orifice of the stomach into that organ. An indispensable part of the process of deglutition is the adjustment

Fig. 146.



DEGLUTITION.—1, 1. Section of head. 2. Spinal canal. 3. Hard palate. 9. Epiglottis. 11. Trachea. 30–34. Pharyngeal muscles. 35–37. Œsophagus.

of the *epiglottis*, as a lid to the larynx, which is by it protected from the entrance of what is swallowed; which must pass over the glottis, as the windpipe lies in front of the pharynx. If one breathes (as in laughing) at the moment of swallowing, *choking* ensues, from a morsel or a drop of liquid going "the wrong way." The irritability of the larynx is itself protective by the violent spasmodic efforts produced, expelling the intruding substance. When we swallow, the pharynx and larynx are *raised up*, by the stylo-pharyngeus and superior constrictor muscles.

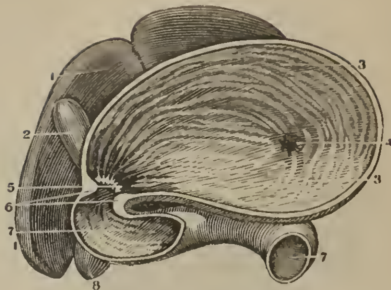
Gastric Digestion.

Entering the stomach, the food is still kept in motion; being carried slowly around by a sort of churning movement of the muscular fibres of the stomach. Thus the *gastric juice* is thoroughly mixed with it. This fluid consists of an acid solution containing *pepsin*. The acid is either chlorohydric (muriatic) or lactic acid; sometimes an acid salt of phosphoric acid. Dr. Dunglison found chlorohydric acid in Alexis St. Martin's[1] stomach, in 1833. The same subject was experimented upon by Profs. R. E. Rogers and F. G. Smith, in 1856; these observers concluding that the principal agent of digestion was lactic acid.

Pepsin is a nitrogenous body, considered to be analogous in its mode of action to the fermenting principle of yeast, or to the

[1] A patient of Dr. Beaumont of Ohio, whose stomach was wounded by the bursting of a gun, leaving a permanent opening or fistula.

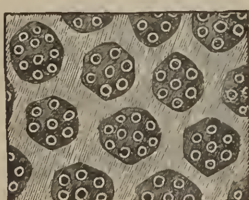
Fig. 147.



THE STOMACH.

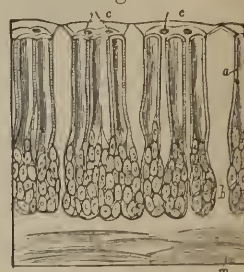
diastase of plants, already alluded to. Being complex, it is prone to chemical change; and, by contact, institutes a *special kind* of chemical movement among the particles of food with which it is mixed. The gastric juice is believed to digest especially *nitro-*

Fig. 148.



MUCOUS MEMBRANE OF THE STOMACH, MAGNIFIED.

Fig. 149.



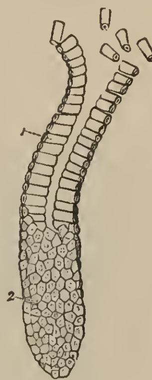
PERPENDICULAR SECTION OF THE SAME.—*a.* Neck of a gastric tubule. *b.* Fundus. *c.* Orifices of tubules. *m.* Muscular coat.

genous food; as the lean of meat, the gluten of bread, and the casein of milk. The products of this digestion have been, by Lehmann, called *peptones;* that of albuminoid food, *albuminose.* Gastric juice is not present in any quantity in the stomach when it is empty; but begins to be secreted by its glands as soon as food is taken. The amounts of the digestive fluids secreted in a man in 24 hours are thus stated by Dr. Dalton :—

Saliva	2.880	pounds.
Gastric juice	14.000	"
Bile	2.420	"
Pancreatic juice	1.872	"
	21.172	"

The result of gastric digestion is called *chyme*. Besides the action of the gastric juice upon nitrogenous matters, no doubt some easily soluble substances are ready for absorption as soon as they enter the stomach. This is probably the case with sugar and dilute alcohol. *Strong* alcohol, as raw spirits, irritates the stomach, and interferes with secretion and absorption. Many dissolved medicines also are absorbed at once, into the capillary bloodvessels of the stomach.

Fig. 150.



FOLLICLES OF PIG'S STOMACH.

The *pylorus* is a muscular valve constricting the right end of the stomach, so as to prevent the passage of undigested food. When reduced to chyme, it is allowed to pass into the duodenum.

Intestinal Digestion.

Bile and *pancreatic* secretion are poured into the duodenum by the ducts of the liver (and gall bladder) and pancreas. It is the common opinion that both continue and complete the digestion of food; especially *fatty* food. In two modes is this believed to take place. One by the alkaline material (soda, potassa) of the two secretions *saponifying* the fat, that is, making a soap by combining with the fatty acid, oleic, palmitic, or stearic, etc. Soap is soluble in water, and thus absorbable; as fat or oil is not. Also, an *emulsification* or suspension takes place, like that made by mixing oil first with gum arabic and then with water; so that in the state of minute subdivision, almost identical with solution, the oil may be absorbed. Dr. Dalton, however, does not admit that the bile takes part in digestion, although acknowledging that very little of it is excreted from the bowels, and that the larger amount of it not passing out must have *some* important function to perform before its re-absorption from the intestinal canal.

Absorption.

The pancreatic juice, containing the organic agent *pancreatin*, is considered by Dr. Dalton and others to *emulsify* fatty materials of food. By this process, and the continued action of the gastric juice derived from the stomach, *chyle* is formed. This is absorbed by the *villi* or minute velvety tufts of the terminations of the *lacteal* vessels. Each villus contains the loop-like beginning of a lacteal tube; and each is covered by a layer of epithelial cells. It is uncertain whether these cells fill by absorption and then burst into the interior of the villus, or whether they simply *transmit* the chyle; probably the latter. Lacteals receive their name from the milky appearance of chyle, which is especially marked after a meal. All of these vessels pass through mesenteric glands to empty into the thoracic duct. Besides lacteal absorption, the *bloodvessels* of the small intestine, like those of the stomach, absorb the products of digestion. This absorption goes on, commonly, very rapidly; carbonate of lithia, for instance, taken into

the stomach, has been detected in the urine in 5 or 10 minutes; ferrocyanide of potassium, in 1 minute. For rapid absorption,

Fig. 151.

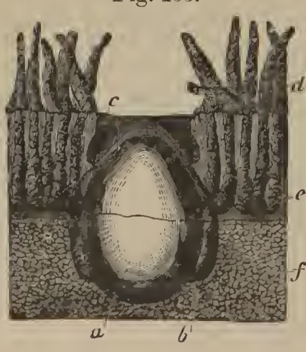
VILLI OF INTESTINE.

Fig. 152.

PIECE OF ILEUM.

substances must be liquid or gaseous; but even insoluble bodies, as oil, or particles of charcoal, slowly find their way into the vessels. The veins of the upper portion of the alimentary canal empty into the *portal vein.* This goes to the liver,

Fig. 153.



SIDE VIEW OF A PORTION OF INTESTINAL MUCOUS MEMBRANE OF A CAT, SHOWING A PEYER'S GLAND (*a*). It is imbedded in the submucous tissue (*f*), the line of separation between which and the mucous membrane passes across the gland. *b*. One of the tubular follicles, the orifices of which form the zone of openings around the gland. *c*. The fossa in the mucous membrane. *d*. Villi. *e*. Follicles of Lieberkühn.

subdividing into capillaries as it enters that organ. Probably the secretion of the *glands of the small intestine* (succus entericus) may have some digestive action; but it has not yet been demonstrated. *Brunn's* (or Brunner's) glands, of the duodenum, secrete a fluid like the pancreatic juice. The glands of Peyer probably belong to the lymphatic system. *Undigested* food is, as refuse, conveyed, by the peristaltic action of the intestinal tube, through the ileo-colic valve to the large intestine, to be excreted as a part of the feces.

Assimilation.

With good reason, this is ascribed as a principal function to the liver; through which so much blood, enriched, after eating, by the materials digested and absorbed, passes, entering by the portal vein. Exactly what is done in this process we cannot explain. After death, Bernard and others have found a *saccharine* substance, glucose, liver-sugar. Pavy asserts this to be a post-mortem educt. A *sugar-producing* substance, at least, glycogen (hepatin, liver dextrin), must be admitted to be formed naturally in the liver. Its after destination is doubtful, except that, by the hepatic vein, it goes on toward the general circulation. Some believe that it acts as a "fuel for combustion," for animal heat, being "burned off" in the lungs. Dr. McDonnel has proposed the view that, in assimilation of blood brought by the portal vein, glycogen combines with nitrogenous materials of the food, to make plastic material for tissue.

Besides the liver, the *mesenteric glands* are almost certainly assimilating organs. Chyle is obviously altered by its passage through them. In fœtal and infantile life the *thymus* and *thyroid* glands probably have the same use. The *lymphatic* glands are supposed to restore to the lymph reabsorbed by the lymphatics (as the surplus of nutrition) all over the body, some qualities necessary for its further utility. Gray ascribes to the *spleen* the office of regulating the quality of the blood, by producing new blood-corpuscles when they are deficient, and destroying a portion of them when they are excessive. It may be remarked that this theory is not certainly established. More probable is the opinion that the spleen is a *diverticulum* or reservoir of blood, receiving it especially from the stomach when that organ is functionally inactive. A case has been reported (*Med. Times and Gazette*, Dec. 7,

Fig. 154.

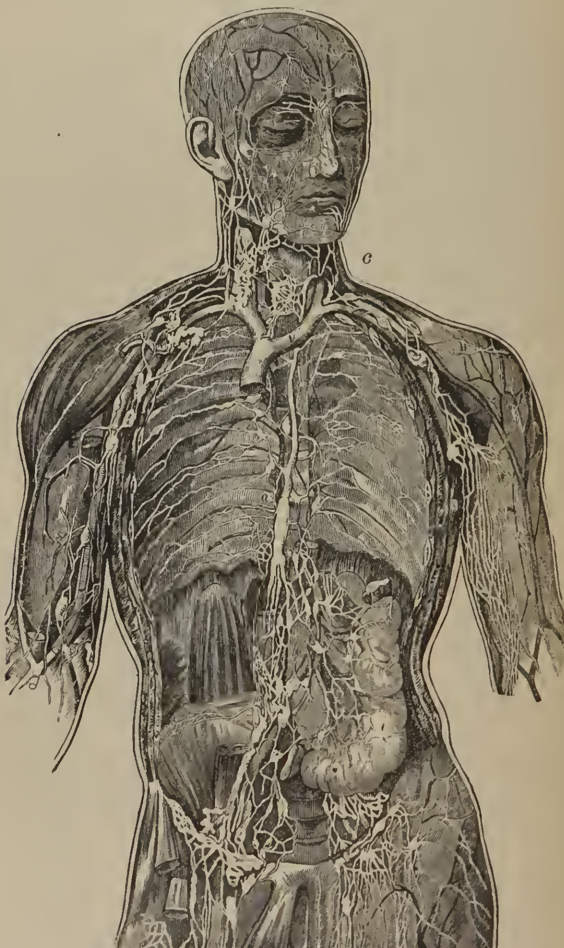
THYMUS.

1867), in which the spleen was removed entirely; yet the woman recovered and seemed to have good health.

Nutrition.

This term may, of course, be attached to *all* that concerns the alimentation of the body. Physiologically, however, it is applied

Fig. 155.



THE LYMPHATICS.—*a.* Receptaculum chyli, commencing the thoracic duct. *c.* Descent of the latter to its termination. *v.* Innominate vein.

more especially to the direct appropriation of plasma of the blood to the building up of the tissues. Nutrition, in this sense, comprises four processes: *formation*, *development*, *growth*, and *repair*. The first two of these are predominant in embryonic life. Growth, as well as development, goes on from conception *in utero* to maturity. After that, *repair* is the only result of nutrition; repair of tissue destroyed in active or passive waste, or by disease or injury. Construction and destruction are going on together throughout life.

In the formation and repair of organs, the *selective* power of cells, or their nuclei, is manifest. *Harmony* of action is also observed in the constructing of contiguous or related parts, as though there were a purposive combination among them. Thus, the eye and its orbit, the brain and the skull, are proportioned to each other. Most wonderful is the exact *symmetry* of the two sides of the body and of most of the organs. When this is interfered with, during gestation and development, deformity results; as *spina bifida* from imperfect union of the two halves of the spinal column, or hare-lip from a similar want of closure near the middle of the face.

The conditions necessary to the healthy nutrition of any part of the body are, 1, a sufficient supply of blood; 2, good quality of the blood; 3, supply of nerve-force; 4, functional exercise; 5, due intervals of repose.

CHAPTER II.

CIRCULATION.

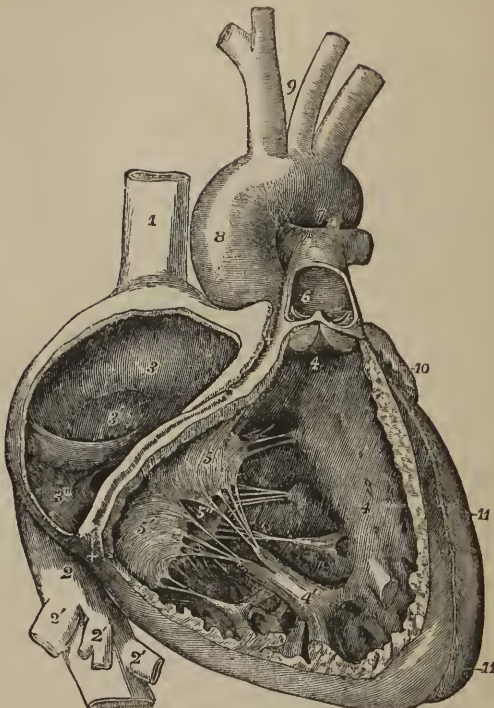
The distribution of the blood throughout the body is effected by the *heart*, *arteries*, *capillaries*, and *veins*; a continuous closed system, with no outlet, except by transudation through the walls of the capillaries.

Action of the Heart.

—The *heart* in man is double, as though two hearts were placed side by side. In fœtal life they communicate directly; but after birth indirectly only. One-half of the heart, the right, receives venous blood from the body and propels it to the lungs; the other, the left, receives arterial blood from the lungs, and, through the aorta and its branches, sends it all over the body. The right half might, therefore, be called the *respiratory* heart, and the left the *systemic*.

Cavities.—Each of these halves of the heart has two cavities; an auricle and a ventricle. The first is a receiving, and the last a propelling cavity. The right auricle receives venous blood from the venæ cavæ, and pushes it on into the right ventricle. This then propels it, through the pulmonary artery, to the lungs. The

Fig. 156.



THE RIGHT AURICLE AND VENTRICLE OPENED, AND A PART OF THEIR RIGHT AND ANTERIOR WALLS REMOVED, SO AS TO SHOW THEIR INTERIOR. ½.—1. Superior vena cava. 2. Inferior vena cava. 2′. Hepatic veins cut short. 3. Right auricle. 3′. Placed in the fossa ovalis, below which is the Eustachian valve. 3″ is placed close to the aperture of the coronary vein. +, +. Placed in the auriculo-ventricular groove, where a narrow portion of the adjacent walls of the auricle and ventricle has been preserved. 4, 4. Cavity of the right ventricle; the upper figure is immediately below the semilunar valves. 4′. Large columna carnea or musculus papillaris. 5, 5′, 5″. Tricuspid valve. 6. Placed in the interior of the pulmonary artery, a part of the anterior wall of that vessel having been removed, and a narrow portion of it preserved at its commencement where the semilunar valves are attached. 7. Concavity of the aortic arch close to the cord of the ductus arteriosus. 8. Ascending part or sinus of the arch covered at its commencement by the auricular appendix and pulmonary artery. 9. Placed between the innominate and left carotid arteries. 10. Appendix of the left auricle. 11, 11. The outside of the left ventricle, the lower figure near the apex.

left auricle receives blood from the lungs, and transfers it to the left ventricle, which then propels it out by the aorta.

The size of the heart is about that of the closed fist. Anatomists state that it continues to grow later in life than any other organ. Each of the ventricles will hold about three ounces; each of the auricles, rather less. The walls of the ventricles are much thicker than those of the auricles; those of the left being thickest. The force of contraction of the left ventricle is estimated by Valentin at $\frac{1}{50}$ of the weight of the whole body; of the right, half as much. The latter has to send blood only through the lungs; the former, through the whole body.

Fig. 157.

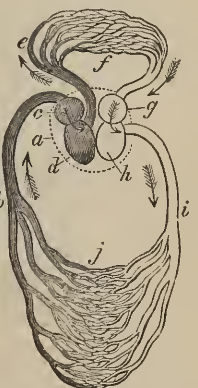


Diagram of the Circulation.

The tissue of the heart (enclosed in the pericardial sac) is *muscular;* of red muscular fibres, spirally arranged; a sort of double or returning spiral. When it contracts, that is, during the *systole* or contraction of the ventricles, the heart elongates[1] (as shown by Dr. Pennock, of Philadelphia), and is twisted forwards so as to strike the left side below the nipple. This constitutes the *impulse.* The *dilatation* of the cavities of the heart appears to result from elasticity only; it has almost no appreciable suction power.

Valves.—Between each auricle and the corresponding ventricle there is a membranous and muscular valve; the tricuspid valve for the right side, the mitral for the left. (See *Anatomy.*) After the auricle contracts, the contraction of the ventricle follows; and with this, the muscular columns of the auriculo-ventricular valve close it against the return of the blood. When the ventricles have contracted, the rebound of the arteries pushes out the pocket-like semilunar valves of the aorta and pulmonary artery, so as to close them together.

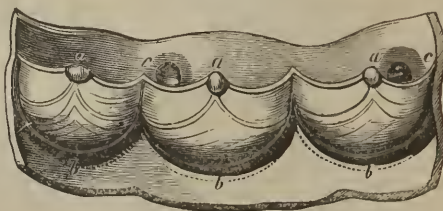
The *cause* of the heart's action is, probably, the contractility of its muscular tissue, under the stimulation of oxygenated blood. Brown-Séquard's theory of its being due to the action of carbonic acid in the blood is untenable. Rhythmic (*i. e.*, regularly alternating or successive) contraction is the general, indeed the universal law of healthy muscular tissue; as has been proved lately by M. Marey's experiments, even when it seems to be continuous, The form of the heart, and the arrangement of its fibres, are such as to give a *magnitude* to its *alternation* of action and repose, such as is only seen in the body elsewhere in the muscular movements of respiration. Although minute ganglia are discoverable in the tissue of the heart, and branches of the pneumogastric nerve go to it, so that it is under the influence of the nervous system, and is often much affected by its condition (as in emotion), yet this influence seems to be modifying rather than essential.

Sounds.—Placing the ear over the heart, we hear two sounds—

[1] The common statement is, that the heart is *shortened* during the systole.

lub-dup—the first longest and loudest. If we divide the whole time of the two sounds and the following pause into four equal parts, the first sound, and the interval between it and the second, will occupy two of these, or half of the whole time of the rhythm; the second sound, nearly one part, or one-fourth of the whole; and the pause a little more than one-fourth. The first sound occurs with the *systole* or contraction of the ventricles; the second, with their *diastole* or dilatation.

Fig. 158.



SEMILUNAR VALVES.

The *causes* of the first sound are, 1, the *closing, with vibration*, of the *auriculo-ventricular valves;* 2, the impulse against the wall of the chest; 3, the rush of blood into the vessels; 4, the friction of the muscular fibres of the heart against each other. The cause of the second sound is, the flapping together of the semilunar valves of the aorta and pulmonary artery, with the arterial rebound during the diastole of the ventricles. During the *first* sound, the ventricles are contracting, and the auriculo-ventricular valves are closed; the semilunar arterial valves are open. During the *second* sound, the ventricles are dilating, the auricles contracting, the mitral and tricuspid valves are open, and the semilunar valves of the arteries closed.

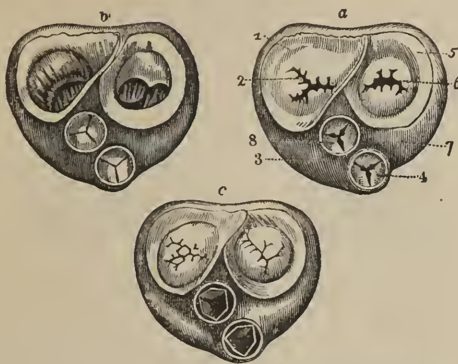
The heart contracts, in an adult, from 70 to 75 times in a minute, while in health and at rest. Its average rate is:—

At birth, times in a minute	110 to 120
First year " " "	120 " 115
Second year, times in a minute	115 " 100
Third year " " "	100 " 90
Seventh year " " "	90 " 85
Fourteenth year " "	85 " 80
Middle life " " "	75 " 70
Old age " " "	70 " 50

In very advanced age, however, sometimes it quickens greatly. Dr. Guy found that the pulse was most rapid in the standing posture; next sitting, slower lying down. This depends on the muscular effort made in supporting the body. In the female it is a little more rapid than in the male of the same age. In disease it is much more often accelerated than retarded. Great debility is nearly always accompanied by acceleration as well as feebleness of the pulse at the wrist, and of the impulse of the heart. Guy found the pulse somewhat more rapid in the morning than in the

evening during health. In disease, it is commonly most rapid in the evening.

Fig. 159.



VIEW OF THE BASE OF THE HEART.—*a*, 1. Right auricle. 2. Tricuspid valve. 3. Right ventricle. 4. Pulmonary artery. 5. Left auricle. 6. Mitral valve. 7. Left ventricle. 8. Aorta. *b* shows the mitral and bicuspid valves open, and the arterial valves closed. *c* shows the opposite; as during the *systole* of the ventricles.

Ordinarily, there is a nearly constant relation between the pulse and the frequeney of the respiratory movements ; there being one respiration to three or fcur pulsations of the heart.

The Arteries.

All arteries, exeept the largest, having (unstriped) museular tissue in their middle coat—the smallest arteries the most—this must have some influenee upon the flow of the blood through them after their reeeption of it from the heart. The arteries are found empty after death ; as, in their last eontraction, they foree the blood into the less resistant veins. Savory asserts the normal state of the arteries during life to be one of *tension*.

The eommon view among physiologists at the present time is, that the sole offiee of the museularity of the arteries is, to *limit*, by *resistance*, the amount of blood passing through them. That is, as Virehow has expressed it, the more healthy and vigorous the action of an artery, the less blood goes through it. This opinion is founded upon some experiments of the Webers ; who found that the intestinal canal, heart, and arteries, when powerfully acted upon by galvanism, were thrown into a state of rigid or *tonic* eontraction. They thenee eoneluded, that, though the intestinal tube has peristaltic eontraetion, and the heart an alternating impulse, the arteries have normally only a power to beeome rigid with a eertain calibre when blood is forced into them.[1] The *elasticity* of

[1] See *Transactions of the American Medical Association*, 1856, and 1872, for arguments by the present writer, in opposition to this view, and advocating the existence of an *actively propelling* power in the arteries.

the arteries must have much to do with the change of the flow of blood, gradually, from an intermittent to a steady stream, such as we find passing from the capillaries to the veins, and through the latter to the heart. If we admitted an active propulsive power in the arteries, supplementary (as Sir Charles Bell held) to that of the heart, the pulse at the wrist, or elsewhere, would be explained by these forces combined. On the current view, however, the pulsation of arteries is due entirely to the impelling action of the heart, driving the blood through them. At the same time, it is well understood that the regulation of the varying supply of blood to different parts must depend mainly upon the condition of the arteries; as the heart acts impartially towards all, having one trunk only, the aorta, to give out its supplies. In the growth of the deer's horn in the spring, the *rutting* or periodical genital excitement of many animals, the development of the uterus during gestation, and of the mammary gland before and during lactation, there is an unusual flow of blood through those organs. Under other circumstances, as in Bernard's experiment of dividing the sympathetic nerve in the neck, arteries are *dilated* passively, by paralysis of the muscular coat. The flushing of the skin upon a blow or friction, or under the stimulation of mustard, ammonia, etc., seems to show a *reflex* action of the bloodvessels, under nervous influence. The experiments of Legros and Onimus (1868–1872) have afforded new and important evidence in favor of the *active* function of the muscularity of arteries. Generally, however, leading authorities in physiology still deny that their muscular contraction contributes to the forward propulsion of the blood.

On the fact that the *vaso-motor* nerves, *i. e.*, those which go to the bloodvessels, are all derived from the ganglia of the sympathetic system, certain speculations concerning the action of cold and heat upon the circulation, through the ganglia, are founded; making the basis of the "ice-bag" and "hot-water bag" practice of Dr. John Chapman. Neither the practice nor the theory is as yet established; nor does the one necessarily depend upon the other.

The Capillaries.

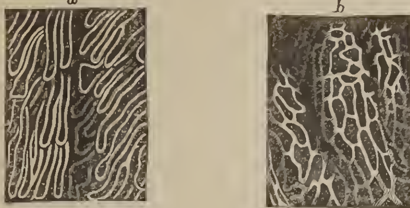
Having but a single coat, without muscularity, these intermediate vessels can have no office but to subdivide, in fine networks, the blood; so that it may afford nutriment, by transudation of the plasma through their walls; or, in the glands, allow secretion; or, in the lungs, expose the blood to the air. Capillaries contract only by elasticity; so as, after being dilated, to return, on the withdrawal of pressure, to their ordinary dimensions.

Yet two powers have been pointed out as, in the capillary region, contributing to the movement of the blood. One of these, as shown by Dr. Draper, is common to plants, animals, and some materials

Also, *American Journal of Medical Sciences*, July, 1868, p. 288. Bouillaud brought before the French Academy some new observations on the subject in 1873; and in the same year Fick made the remarkable discovery that the pressure in the aorta is greater than in the left ventricle.—See *Nature*, Nov. 6, 1873, p. 19.

of an inorganic nature; viz., capillary action; that is, the attraction of the walls of fine tubes for liquid in which they are immersed,

Fig. 160.

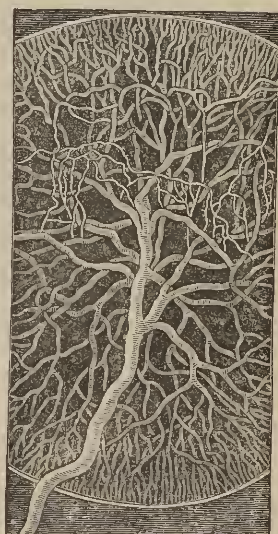


CAPILLARIES.—*a*. Capillaries of the papillæ of the skin of a finger. *b*. Capillaries of villi of small intestine.

varying with the smallness of the tube and the nature of the materials used.

The other agency, first pointed out by Dr. Draper, is also present both in animals and plants. It is the attraction which the tissues of the organism have for the nutritive materials circulating in its vessels. This "vital or nutritive affinity" is a *vis à fronte;* which, as it constantly takes, in nutrition, particles from the blood in the capillaries, must diminish pressure in resistance, and favor the onward flow.

Fig. 161.



CAPILLARIES OF A TOOTH.

The Veins.

Valves along the course of nearly all the veins, opening only towards the heart, economize the power used in returning the blood through them (from the capillaries) to the heart. The pressure of the muscles during exercise contributes to the same end. So does *inspiration* tend to promote the return of the blood through the venæ cavæ to the heart; since the lifting of the ribs lessens the pressure upon the heart's surface, or, in other words, exerts some "suction" power upon it. The *larger* veins have an appreciable amount of muscular tissue; the smaller ones, none. It is natural to suppose that this is because the largest, being nearest the end of the round of circulation at the heart, require the most power to complete the circuit. The *velocity* of the blood-movement is greater in the arteries than in the veins. The *capacity* of the

venous system is about three times as great as that of the arterial system; and the angles at which branches join the veins are much larger than those at which branches leave the arterial trunks. These facts account for the greater slowness of the venous current.

By experiments with chemical reagents introduced into the veins, it has been shown that the blood passes around its course in *less than half a minute*, in some instances, and in others in about a minute. It is not equally rapid at all times, nor even through all the different organs of the same body.

Route of the Circulation.

Although hardly necessary in this place, we may recapitulate the round of the circulation, as follows: Beginning at the aorta, the blood is distributed by its branches to all parts of the body. The small arteries terminating finally in capillaries, these, in various networks, subdivide the blood for the supply of the different organs. Then the capillaries unite to form veins, and these, larger ones, till finally all combine to end in the ascending and descending *venæ cavæ*. These empty into the right auricle. This pours its blood through the tricuspid valve into the right ventricle; which, by the pulmonary artery and its branches, sends it to the lungs. Thence, by the four pulmonary veins, the blood is brought to the left auricle. Through the mitral valve, it is passed on into the left ventricle; whence it again is thrown into the aorta. The *portal* circulation of the liver is, as has been already explained, a deviation from this simple course of the general system; since the portal vein, instead of going to empty its contents directly into the venæ cavæ, breaks up into capillaries to enter the liver; whose blood is then collected by the hepatic vein, by which it is conveyed to the vena cava.

The discovery of the course of the circulation was made by Dr. William Harvey, about 1619.

The movement of the blood in the *lymphatics* is slow and almost passive in man; but in reptiles and certain birds, *lymph-hearts* exist.

CHAPTER III.

RESPIRATION.

This function has for its purpose the aeration of the blood. It is accomplished by the exposure of the venous blood, brought from the right half of the heart, to the air received into the air-vesicles of the lungs. The immense number of these vesicles (about six hundred millions), provides a very large expansion of surface. Air and blood both periodically enter and pass through the lungs; although the blood is entirely confined within the capillaries. The heart sends a new supply of venous blood with every systole; the lungs receive a fresh quantity of air with each inhalation.

Movements of Respiration.

These are, *inspiration* and *expiration*. The first is accomplished by expanding the chest, so as to take pressure from the outside of the lungs, while the mouth or nostrils are open to allow the entrance of air. It is precisely the action of filling a pair of bellows with air by drawing apart the handles. This expansion of the chest is effected in two ways: 1. elevation of the ribs by the intercostal muscles; 2 depression of the diaphragm by its own contraction.

Fig. 162.

DIAGRAM OF AIR-CELLS.—1. Small bronchial tube. 2. Vesicular portion of lobule. 3. The same, laid open.

The intercostal muscles, internal and external, have their fibres crossing in opposite directions. This obliquity adds to the extent of their action (if they act together) in lifting the ribs; as every muscle shortens, in its contraction, about one-third of its length, therefore the longer it is, the greater the distance through which it draws what it moves. The ribs are elevated principally by the *external* intercostals, and those portions of the internal which are between the *cartilages* of the ribs. Breathing chiefly by action of the intercostal muscles in lifting the ribs is called *costal* respiration; that by the diaphragm mainly, *abdominal* respiration. The latter is observed in young children; the costal type, in women. Abdominal respiration is so called, because, when the diaphragm descends, it forces out the organs of the abdomen perceptibly.

In violent efforts of inspiration, as in asthma or croup, accessory muscles of respiration assist the intercostals and diaphragm. The principal of these are the *levatores costarum.* But other muscles may contribute aid—even those of the neck; and sometimes the nostrils are forcibly dilated in the struggle for air.

Ordinary *expiration* follows the cessation of the muscular act of inspiration, not requiring any positive effort of muscular contraction. The weight of the ribs causes them to fall; the elasticity of the diaphragm makes it ascend; the same property in the lungs induces their contraction and the expulsion of the air. The elasticity of the costal cartilages also assists. *Forced* expiration, however, as in blowing hard, involves (besides the accessory action of the internal, especially the lower intercostals and the *sterno-costalis* muscle) compression upward of the diaphragm, by the superficial *muscles of the abdomen* (external and internal oblique, transversalis, and rectus) pressing inward the contents of the cavity under them.

Fig. 163.

THE CHANGES OF THE THORACIC AND ABDOMINAL WALLS OF THE MALE DURING RESPIRATION. —The back is supposed to be fixed in order to throw forward the respiratory movement as much as possible. The outer black continuous line in front represents the ordinary breathing movement; the anterior margin of it being the boundary of inspiration, the posterior margin the limit of expiration. The line is thicker over the abdomen, since the ordinary respiratory movement is chiefly abdominal: thin over the chest, for there is less movement over that region. The dotted line indicates the movement on deep inspiration, during which the sternum advances while the abdomen recedes.

Fig. 164.

THE RESPIRATORY MOVEMENT IN THE FEMALE.—The lines indicate the same changes as in the last figure. The thickness of the continuous line over the sternum shows the larger extent of the ordinary breathing movement over that region in the female than in the male.

Quantity of Air Changed.

With each breath, a man changes about thirty to thirty-five cubic inches of air. By forced expiration, one can expel a much larger amount. Still a quantity will remain in the lungs, which cannot be driven out. This *residual* air varies probably from forty to two hundred and sixty cubic inches.

After a deep inspiration, a healthy man, five feet seven inches in height, can, on the average, expel from his lungs two hundred and twenty-five cubic inches of air. This was called, by Mr. Hutchinson, the *vital capacity*. For every inch above the height just named, the capacity of the chest increases about eight cubic inches; and for every inch below, it is diminished in the same proportion. Less regular correspondence exists in regard to weight.

Mostly it does not vary much with weight under one hundred and sixty-one pounds. Over that, each additional pound of weight brings a cubic inch of diminution in vital capacity, so called. With age, this increases from fifteen to thirty-five years, at the rate of five cubic inches per year. Then it diminishes, one and a half cubic inches each year, to sixty-five years. Bourgery states that women have but half the breathing capacity of men of the same age.

Fig. 165.

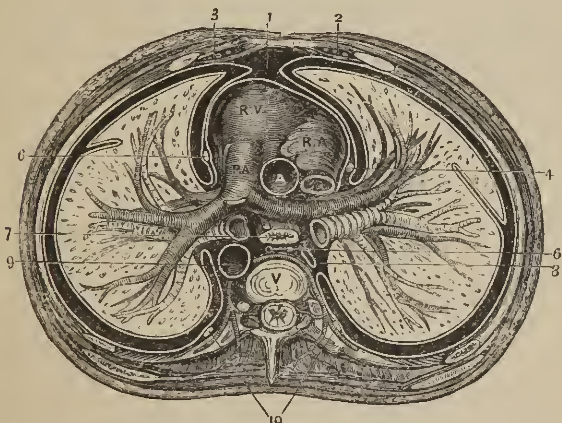


DIAGRAM OF A TRANSVERSE SECTION OF THE THORAX.—1. Anterior mediastinum. 2. Internal mammary vessels. 3. Triangularis sterni muscle. 4. Right phrenic nerve between pleura and pericardium. 5. Left phrenic nerve between pleura and pericardium. 6. Thoracic duct in posterior mediastinum. 7. Œsophagus with left vagus in front and right vagus behind. 8. Vena azygos major. 9. Thoracic aorta giving off intercostal arteries. 10. Gangliated cord of sympathetic. R. V. Right ventricle. R. A. Right auricle of heart in middle mediastinum. P. A. Pulmonary artery. A. Aorta. C. Vena cava superior. V. Dorsal vertebra.

The *number* of respirations usual in an adult in health is from fourteen to eighteen in a minute. The *force* of a full, deep inspiration is calculated to be equal to a weight of four hundred and fifty pounds lifted.

Changes of the Air Breathed.

Common air consists of nearly seventy-nine volumes of nitrogen, and twenty-one of oxygen ; with about four parts in ten thousand of carbonic acid, a variable amount of watery vapor, and some non-essential gases and particles.

After passing through the lungs, a portion of air has become *warmer;* its *oxygen* is *diminished*, its *carbonic acid* and *watery vapor increased.* The increase of carbonic acid may be shown by

the milky turbidness produced by breathing into clear lime-water. The vapor of water in the breath is made known in the open air on a cold day, by the cloud condensing near the nostrils or mouth.

For every thousand volumes of carbonic acid exhaled, Valentin and Brunner assert that over one thousand one hundred and seventy-four volumes of oxygen gas are absorbed into the blood. In an hour, 1583.6 cubic inches of oxygen are absorbed on the average. Pettenkofer has shown that more oxygen is taken in at night than during the day.

Of carbonic acid, about 1345.3 cubic inches are given out every hour, containing one hundred and seventy-three grains of carbon; or eight ounces of carbon in twenty-four hours. The amount of this exhalation varies, however, with *age*, *sex*, *temperature*, and *purity* of the *air*.

From eight to thirty years of age, in males, the amount of carbonic acid exhaled increases; from thirty to forty it is nearly the same; after that time it diminishes gradually. In females, it is less than in males of the same age; it increases from eight years till puberty, and then remains stationary throughout the menstrual and child-bearing period of life.

The *faster* one breathes, the *less* is the proportionate amount of carbonic acid exhaled. As to *temperature*, between 38° and 75° Fahr., every rise of 10° is attended by a lessening in the carbonic acid given out, of two cubic inches per minute.

An atmosphere containing five or six per cent. of carbonic acid gas is not capable of long sustaining life. Ten per cent. may produce immediate danger. While pure carbonic acid is irrespirable, its dilution causes it to be tolerated by the breathing organs. Hence the peril of life in some deep wells, brewers' vats, and rooms in which charcoal is allowed to burn without ventilation.

The use of *food* increases the amount of carbonic acid in the air expired. *Alcoholic* drinks diminish it. *Exercise* increases it. *Sleep* diminishes it. This fact is not inconsistent with Pettenkofer's observation, above stated, of the greater absorption of oxygen during the night. This gas probably is, during sleep, utilized in *construction* and repair of tissue; not in consumption of fuel in the blood to generate force, from which the greatest amount of carbonic acid results.

The amount of *watery vapor* exhaled from the lungs is, on the average, nearly a pint in twenty-four hours.

Changes Produced by Respiration in the Blood.

The *color* of the blood is altered in the lungs, from dark crimson or purple to bright scarlet. The blood is also 1° or 2° *warmer*;[1] it contains *more oxygen*, *less carbonic acid*, and more fibrin. The introduction of oxygen gas, and the elimination of carbonic acid gas, are, as already observed, the two great purposes of respiration. Venous blood is that which has been, by various influences during its flow, rendered unfit for the support of vital energy. Arterial blood has been revivified by its purification and oxygenation.

[1] This is not admitted by all observers.

When these changes are prevented, as in strangulation, drowning, or *asphyxia* by irrespirable gases, the dark blood is unable to maintain the vitality of the nerve-centres; and the blood ceases even to flow through the vessels. Drowning occurs, therefore, not from any directly injurious effect of the water in the lungs, but from the simple exclusion of air. So in some of the deaths from inhalation of chloroform, the cause probably has been the deficient admixture of air with the anæsthetic. That substance is, however, capable of causing fatal arrest of respiration, apparently by its toxic influence upon the *medulla oblongata*, the nerve-centre of respiration.

Recovery from drowning seldom occurs when the individual has been submerged as long as five minutes. Rare instances are narrated, in which it has been fifteen minutes. Even practised pearl-divers can seldom stay under water for one whole minute at a time.

Animal Heat.

In the armpit, or under the tongue, the temperature of the adult human body is, in health, 98°.4 or 98°.5 Fahr. The heat of the blood is 100° to 103°. Children have a temperature two or three degrees higher. In disease, especially in scarlet fever and yellow fever, it has been known to reach 108°, and, it is said, 112°. Cholera, pernicious fever, and *cyanosis* are attended by depression of temperature. In cholera, it has gone down during life to 77°. Other parts of the body are cooler than the armpit; the sole of the foot does not average in health above 90°. During sleep, the heat of the body goes down about 1½ degree. It is highest early in the morning, fluctuates through the day, and is lowest about midnight. Exercise elevates it considerably; eating does so to a less extent. The reaction following a cold bath may raise it one degree or more.

As we are constantly giving off heat to surrounding bodies, by radiation, conduction, and evaporation, it must be supplied by processes going on within the system. The explanation long held by physiologists to be most probable is, that our animal heat is produced by *slow combustion;* that is, the union of oxygen with the carbon, hydrogen, nitrogen, sulphur and other elements of the blood and tissues, giving out heat less rapidly, but in the same quantity, as when wood, coal, oil, or other fuel is burned in the air. Liebig has asserted, on calculation, that the amount of carbon and hydrogen shown to unite with oxygen in the body is sufficient to account for all its animal heat. Warm-blooded animals always breathe a great deal of air (birds, for example), and consume a great deal of carbonaceous food. Whether materials of food are ever "burned off" from the blood in the generation of heat, without entering first into the tissues, is not certain; probably it is so. In cold climates, Arctic explorers have found the demand for fatty (carbohydrogenous) food to be very much greater than in warm or temperate regions.

It must be understood, however, that the "combustion" of materials in the body is not, like that of wood or coal, a simple process of direct conversion of carbon, by oxidation, into carbonic

acid, and of hydrogen into water. Step by step combinations are formed, of which the *last results*, only, are these familiar substances.

Prof. Dalton regards animal heat as the result of a chemical, but not strictly of a combustive process. His language is, in part, as follows:[1] "The numerous combinations and decompositions which follow each other incessantly during the nutritive process, result in the production of an internal or vital heat, which is present in both animals and vegetables, and which varies in amount in different species, in the same individual at different times, and even in different parts and organs of the same body."

The *nervous* system has a considerable though unexplained influence over animal heat. This is shown by the coldness following great shocks to the nervous centres, the loss of temperature in paralyzed limbs, and the occasional increase of temperature under nervous excitement.

The power of resisting the depressing action of exposure to cold is greatest in adolescence; least in infancy and old age. Clothing, by its non-conducting property, *retains* heat, that is, prevents or retards its loss; but it does not *make* us warm, in a positive sense.

CHAPTER IV.

EXCRETION.

BESIDES carbonic acid, which must be thrown out from the blood, other substances, results of chemical changes in the different parts of the living body, have to be removed from it. No particle seems to remain *permanently* in the form and condition in which it is organized; but each passes from the organic to the *effete* or post-organic state: when, if retained, it will be obstructive and injurious to the system. Poisonous and even fatal effects may result from the retention in the blood of excrementitious matter; as, in *uræmia*, when the action of the kidneys is suppressed; *cholæmia*, when the liver fails to secrete bile, etc. *Toxæmia* is blood-poisoning from any cause. This is prevented very often, even when delete-

Fig. 166.

BRUNNER'S GLAND, MAGNIFIED.

[1] Treatise on Physiology, 4th edition, p. 247.

rious agents have been taken into the blood, by the emunctories or excretory organs eliminating it.

Excretion is always a secretory process; but secretion is not always excretion. The former term is applicable whenever anything is, by glandular or follicular action (*i. e.*, by the selective power of cells), separated from the blood. The latter, excretion, occurs only when the material removed is altogether *waste*, and cannot be used for any purpose connected with the organism. Milk, for instance, is a secretion, but not an excretion; because it is available, and is produced, for the nourishment of offspring. Urine and feces are entirely excretory. Bile is only partly so.

Secretion and excretion being, however, so nearly alike in nature, we may, without impropriety, enumerate together their most definite products as follows:—

Ptyalin,	Cholesterin,
Pepsin,	Taurocholic acid,
Pancreatin,	Glycocholic acid,
Creatin,	Glycogen,
Creatinin,	Excretin,
Lactic acid,	Stercorin,
Lactin,	Urea,
Butyrin,	Uric acid.

Pigments, as biliary coloring matter (biliverdin, biliphain, or cholepyrrhin) and coloring matter of the urine (urosacin, uroxanthin).

Also, excretory *salts;* as urates, phosphates, sulphates, etc., dissolved in water.

The organs which are altogether excretory, in the human economy, are, the kidneys and the large intestine. Partly so, are the lungs, liver, and skin. Having considered already the functional action of the lungs, we may now briefly attend to that of the liver, kidneys, bowels, and skin.

Secretion of Bile.

Only the liver, of all the glands of the human body, is supplied with venous as well as arterial blood. Although the main purpose of this is, probably, the assimilation of crude blood coming from the digestive organs, it is not possible to prove whether the bile is mainly produced from the blood of the hepatic artery or from that of the portal vein. That vein is supplied by branches from the stomach, spleen, pancreas, and small intestine. Entering the liver by two main branches, the portal vein subdivides and ramifies into the *interlobular veins.* These, as well as the minute branches of the hepatic artery, make the capillary networks, which surround the *acini* or lobules of the liver. From the centre of each of these lobules or

Fig. 167.

LOBULE OF LIVER.

"islets," goes off a ramule (intra-lobular vein) contributing to the hepatic vein. From the same acini also pass off the tubules which carry bile, and which by combining make finally the biliary or hepatic duct. Among the capillary meshes of the acini, and inclosed within these, so as to be in direct contact with the biliary tubules, lie the *secreting hepatic cells*. These take from the blood materials from which they elaborate the bile.

Fig. 168.

LOBULE OF LIVER

Leaving the liver, the bile commonly goes backward through the gall-duct to the *gall-bladder*, where it is held in reserve, to be forced out, by the *ductus communis choledochus*, into the duodenum, from time to time.

Human bile is yellowish-brown in color, and of a peculiar acrid or bitter taste. Its reaction to test paper is disguised by its bleaching litmus; but it is probably neutral when fresh, tending to alkalinity on keeping. It makes a lather-like foam when shaken in a tube. Nearly two and a half pounds of bile are estimated to be secreted by an adult in twenty-four hours.

Characteristic *ingredients* of bile are, *biliverdin* (coloring principle), *cholesterin*, *glyco-cholate*, and *tauro-cholate* of *sodium;* also chloride of sodium, oleate, margarate, and stearate of sodium and potassium, carbonate and phosphate of sodium and potassium, and phosphates of calcium and magnesium.

Biliverdin does not pre-exist in the blood. It must be formed in the liver, probably from cruorin of the blood. After its formation, it may be re-absorbed, when, for instance, the gall-duct is obstructed by gall-stones, and then it may be thrown out from the blood into the skin (jaundice) and tissues and secretions generally. It is a nitrogenous substance.

Cholesterin is a fat-like non-nitrogenous crystallizable substance, distinguished from the fats by not making soap with alkalies. It is not formed in the liver, but reaches it in the blood, being derived apparently from the waste of tissue in the brain and other parts of the nervous system, and from the spleen. Cholesterin is, according to the investigations of Prof. A. Flint, Jr., changed into other substances (stercorin, excretin) in the intestinal canal; not

being found in the fcees. About ten grains of stereorin are asserted to be secreted daily.

Bilin or *biliary resin* eonsists ehiefly of *glyco-cholate* and *tauro-cholate of sodium.* The former of these erystallizes readily; the latter with difficulty, if at all. They are distinguished also by the fact that the first is precipitated by acetate of lead, while the other is not. Both are nitrogenous; but tauro-cholie aeid is peculiar in containing sulphur. These substances are *formed in the liver.*

Fig. 169.

CRYSTALLINE SCALES OF CHOLESTERIN.

Pettenkofer's test for bile is believed to be the best. It eonsists essentially in mixing with the liquid to be examined a little cane sugar, and then adding sulphuric acid, drop by drop. A red color appears, ehanging gradually to lake, and finally opaque purple.

Biliary *coloring* matter, but not the resinous salts of the bile, is tested by nitrie acid; which produces a green eolor with it.

Fig. 170.

SECTION OF THE LIVER OF THE HORSE.

Uses of the Bile.—Most physiologists ascribe to the bile a share with the panereatie seeretion in the digestion of the fat of our food. It is usually seereted in largest amount not long after a meal. Nearly all of the biliary substanees proper are reabsorbed from the intestine. Experiment shows that it is neeessary to

health and even to the life of an animal, not only that the bile should be secreted and discharged, but that it should be passed *into the alimentary canal.* All these facts combine to prove that it partakes in the completion of the digestive process. Against this, Dr. Dalton urges that experiments with bile out of the body have not succeeded in showing that it has any positive reaction with either albumen, starch, or fat, at a temperature of 100°.

Fig. 171.

BILE-DUCT AND CELLS.

Probably the bile also acts as the natural "peristaltic persuader," or stimulant of muscular contraction in the intestine. By its proneness to alkalinity, it may neutralize excess of acidity in the bowels; and, by its antiseptic quality, retard putrefactive changes in the refuse of blood.

Secretion of Urine.

There is no doubt that it is in the *cortical* portion of the kidney that urine is secreted. There are the *cells* of the organ, in close relation to the beginnings of the uriniferous tubules, which then collect, in conical bundles, to end at the pelvis of the kidney. Capillary bloodvessels surround these cells; each minute tubule also begins in a capsule, which embraces a Malpighian corpuscle, or tuft of capillaries. Very possibly there may be an actual expression or filtration of a portion of the water and salts of the blood, from the Malpighian tufts, into the tubules, through the inclosing capsule. Besides this, however, there is a true *secretion*, or selective separation of matters from the blood, by the cortical renal *cells*.

Fig. 172.

SECTION OF KIDNEY.

Urine is entirely excrementitious; serving, after it leaves the kidney, no functional purpose. Its ingredients are all taken from the blood; not manufactured, although, perhaps, somewhat modified in the kidney.[1] The average daily amount in an adult is from thirty to fifty fluidounces. Its normal specific gravity (water being 1000) is about 1020. Its quantity and character, however, both vary, even in health; and, greatly, in disease. Diabetes mellitus is marked by saccharine urine, which is very heavy; up to 1060 or 1070. Hysterical patients often have very abundant urine, pellucid and light; 1006 or 1005. *Albuminuria* is the presence of albumen in the urine. This occurs transiently in a number of diseases; permanently, in Bright's disease of the kidney. The acid sulphates and phosphates do not exist, as such, in the blood, and must, therefore, be produced by the action of the kidneys.

Diurnal variations take place in the urine in health. Dalton found that passed on rising in the morning to be dense, highly colored, and of acid reaction. During the forenoon, pale, light in weight, and neutral or slightly alkaline. In the afternoon and evening it becomes again dense, dark colored, and strongly acid.

Average quantity of the chief constituents of the Urine excreted in 24 hours by healthy male adults (*Parkes*).

Water	52	fluidounces.
Urea	512.4	grains.
Uric acid	8.5	"
Hippuric acid, uncertain	probably 10 to 15	"
Sulphuric acid	31.11	"
Phosphoric acid	45	"
Chlorine	105	"
Chloride of ammonium	35.25	"
Potash	58	"
Soda	125	"
Lime	3.5	"
Magnesia	3	"
Mucus	7	"
Extractives { Creatin, Creatinin, Pigment, Xanthin, Hypoxanthin }, Resinous matter, etc.	154	"

[1] Zalesky asserts that the kidneys change creatin into urea.

Average quantity of each constituent of the Urine in 1000 parts.

Water				967
Urea				14.230
Uric acid				.468
Coloring matter			inseparable from each other	10.167
Mucus, and animal extractive matter				
Salts	Sulphates	Sodium, Potassium		8.135
	Bi-phosphates	Calcium, Sodium, Magnesium, Ammonium		
	Chlorides	Sodium, Potassium		
	Hippurate of sodium			
	Fluoride of potassium			
Silica				traces
				1000.000

Urea is a soluble, crystallizable, neutral, nitrogenous substance; of which the daily average passed by an adult in the urine is from

Fig. 173.

STRUCTURE OF KIDNEY.—*a*. Arterial branch. *b*. Malpighian tuft *cf*. Efferent vessel. *m*, *m*. Capsule. *t*. Uriniferous tubule.

400 to 600 grains. It is increased by violent, though not by moderate exercise; and by highly animalized food. Out of the body, decomposition converts it into carbonate of ammonium.

Creatin is a crystallizable, neutral, nitrogenous substance, originating in the muscular tissue as a result of its waste. Being absorbed into the blood, it is thrown out in the urine.

Creatinin contains two equivalents less of water than creatin. It is slightly alkaline. Muscular tissue yields it also. Probably creatin is converted into creatinin; as the latter substance is most abundant in the urine, and the former in the muscles.

Urates, or salts of uric or lithic acid, are soluble and crystallizable salts, containing nitrogen. Urate of sodium is the most abundant. They result from the waste or disintegration of the nitrogenous tissues. The *rate* of *metamorphosis* of tissue, therefore, can be approximately estimated by determining the amount of urea, urates, etc., passed. A very small amount of *hippuric* acid can be detected in human urine; but it is more abundant in that of herbivorous quadrupeds.

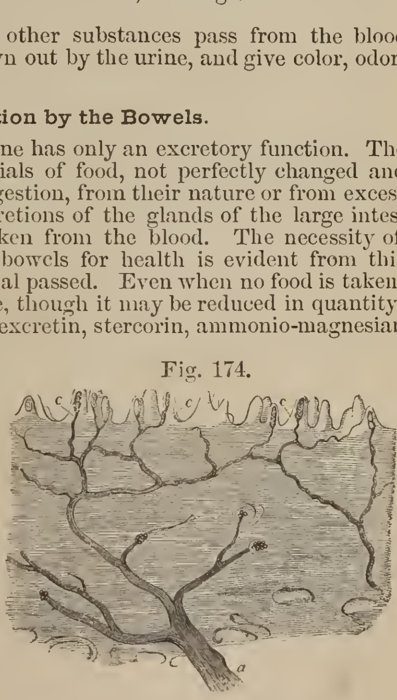
The *coloring matter* of the urine, *urosacin*, is usually dissolved in the water of the secretion. Sometimes it is thrown down with other deposits, as uric acid or the urates; making the "lateritious" or brickdust sediment.

Various medicinal and other substances pass from the blood into the kidneys, are thrown out by the urine, and give color, odor, or other properties to it.

Excretion by the Bowels.

In man, the large intestine has only an excretory function. The *feces* consist, 1st, of materials of food, not perfectly changed and rendered assimilable by digestion, from their nature or from excess in amount; 2d, of the secretions of the glands of the large intestine, viz., effete matter taken from the blood. The necessity of the regular action of the bowels for health is evident from this double nature of the material passed. Even when no food is taken, as in illness, *some* discharge, though it may be reduced in quantity, is required. In the feces, excretin, stercorin, ammonio-magnesian phosphate, and other salts, have been found along with remnants of undigested food. The average daily amount of the feces is 5 ounces.

Fig. 174.



Section of Skin.

The Skin.

Two important uses, besides secretion, evidently belong to the skin; *protection* of the organs beneath it, and the reception and conveyance of *sensation*. Two kinds of secreting glands are found in it; the

sudoriparous or sweat-glands, and the *sebaceous* glands. The former are most abundant; on the palm of the hand, for instance, 2700 to the square inch. Each sweat-gland is a tubular coil, lined with epithelium, lying just beneath the skin. Its duct penetrates the skin, ending at the cuticle with an oblique valve-like opening. Altogether, nearly two pounds of perspiration pass off from the body of an adult in twenty-four hours. Its composition is about as follows:—

Water	995.00
Animal matters, with lime	.10
Sulphates, with substances soluble in water	1.05
Chlorides of sodium and potassium, and spirit-extract	2.40
Acetic, butyric, and formic acids, acetates, lactates, urea, etc.	1.45
	1000.00

The *sebaceous* glands abound especially upon parts of the skin covered with hair. Their secretion is unctuous, and maintains the suppleness of the skin and hair. In the *external meatus* of the ear, the *ceruminous* glands discharge a matter of a peculiar consistence and odor, whose purpose seems to be chiefly to exclude insects from the ear.

Insensible perspiration is an exhalation of moisture from the whole surface of the skin. By its evaporation and that of the *sweat*, the heat of the body is moderated, under exercise, in summer weather or tropical climates. Thus, in a dry air-bath, the temperature of 250° can be readily sustained; in vapor, 150° would be dangerous. Chabert, the Fire-king, is said to have entered safely an oven heated to 600°.

Under some circumstances, the skin *absorbs water*, as in bathing; and occasionally it even absorbs moisture from the air.

CHAPTER V.

REPRODUCTION.

General Considerations.

For the indefinite continuance of species of organized beings by the reproduction of individuals, the essential condition is the union of two oppositely polar or "sexual" cells; the *germ-cell* and the *sperm-cell*. In the higher animals, as in man, these are always the products of different bodies, having concomitant sexual peculiarities. Among lower forms, animal and vegetable, true *hermaphrodism* is sometimes met with; *i. e.*, the existence of both sexes in the same individual; as in the tapeworm. Still, even if the uniting cells do not exhibit any palpable differences, the principle of *duality* seems to be universal in reproduction.

Apparent exceptions exist to this law, in several instances. The propagation of plants from cuttings (as of the grapevine), or

from "eyes" of tuberous roots (as of the potato), is certainly not a *dual* process. If, then, this be infinite in its possible extent of multiplication, it must be exceptional. But we do not know that it is so. Degeneration of the potato and other plants under that method has been noticed. If this *multiplication by division* be exhaustible, it is really only the separate growth of dividual parts of the unity of organization from which they came. The tree grows in its cuttings; and, although their life is prolonged beyond that of the branches which are not planted out, it is still limited; only seed-life is perpetually renewable.

Other seeming exceptions occur in "parthenogenesis," or reproduction without impregnation, and the "alternation of generations" of certain animals (medusæ, salpæ, etc.), whose offspring are quite different from themselves. Careful examination has, however, shown that, while it may sometimes be deferred for several generations, sexual union does at intervals always occur. This is not necessarily in the bodies of the animals; as, in the case of fishes, the *spawn* and *milt* meet in the water outside of both parents.

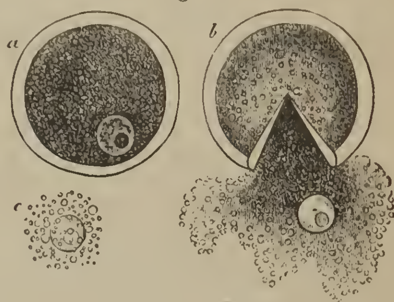
Parasites within the cavities of the human and other animal bodies were once a serious puzzle to physiologists. It is now well understood, however, that all of them must be, and can be shown to be, derived from other, like or unlike, forms whose germs enter the body in food or drink, through the skin, or after being variously deposited as eggs. So the tapeworm comes from the *cysticercus*, swallowed while very small, in food.

Some facts have often suggested the idea of "spontaneous generation;" that is, of the springing up of life in previously inanimate organic matter. Vegetation and animal life do certainly appear often, on the surface of decaying liquids and solids, without visible sources of origination. Any infusion of organic matter left exposed to the air for some days in warm weather, will display under the microscope a number of animalcules and minute but definite vegetable growths. These, at least those whose motions give the idea of animality, are called *infusoria*. Do they ever begin to exist without previous germs?

Nearly all physiologists and naturalists are now agreed upon the theory of Pasteur, that the atmosphere and common water, which "teem with life," are always the sources of such development, by the ordinary methods of reproduction from parentage. Some experiments of Prof. Jeffries Wyman would seem to have settled this point fully. Having, with the greatest care, prevented all air except what had been exposed to high heat and disorganized by sulphuric acid, from reaching a preparation of organic matter, he found the number of infusoria and vegetations produced to be greatly diminished. Some appeared, even after four hours' boiling of the materials. After *five* hours' boiling, however, *none appeared.* This shows, first, that the resistance of some of these minute germs to the destructive action of high temperature is greater than had been supposed; and, also, that a certain degree and continuance of such exposure will destroy *all* living particles; after which none are spontaneously produced. *Omne animal ex ovo*, Harvey's dictum, is then verified. Frankland, Calvert, Lister, and others have confirmed this conclusion by their experiments;

although Pouchet and others have long disputed in favor of spontaneous generation; and Dr. Charlton Bastian elaborately maintains this doctrine.

Fig. 175.



UNFERTILIZED OVUM.—*a*. Vitelline membrane, inclosing the yelk and germinal spot. *b*. The germ-cell, burst. *c*. The germinal vesicle, surrounded by granular matter.

Of woman, the *ovary* is the primary organ of reproduction. In it the ova are produced, and, once a month, an ovum is thrown off, by the Fallopian tube, into the uterus. The *Graafian vesicles* are the minute sacs or cavities in which the ova are formed. Each undergoes certain changes before, and still more after, its rupture and the discharge of an ovum. There is then left a small

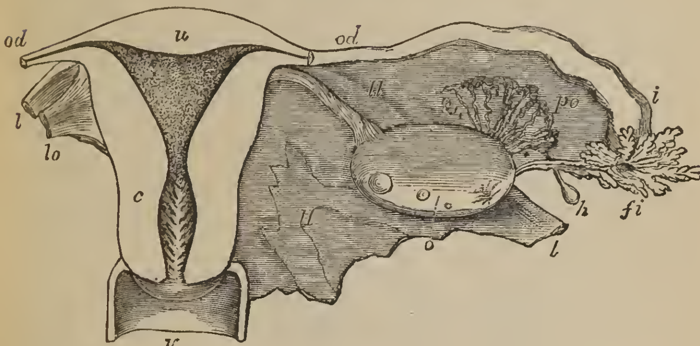
Fig. 176.

GRAAFIAN VESICLE AND OVUM.—1. Stroma of ovary. 2, 3. Tunics of Graafian vesicle. 4. Cavity of vesicle. 5. Yelk-sac. 6. Yelk. 7. Germinal vesicle. 8. Germinal spot.

mass called the *corpus luteum*. This is larger, and persists considerably longer when pregnancy occurs; but the difference is not sufficiently marked and constant to afford certain evidence of impregnation. If not impregnated by sexual intercourse, the

ovum is then carried out by the (mucous and hemorrhagic) *menstrual discharge* from the uterus. This, the womb, is the organ of

Fig. 177.



DIAGRAMMATIC VIEW OF THE UTERUS AND ITS APPENDAGES, AS SEEN FROM BEHIND. ½.—The uterus and upper part of the vagina have been laid open by removing the posterior wall; the Fallopian tube, round ligament, and ovarian ligament have been cut short, and the broad ligament removed on the left side. *u.* The upper part of the uterus. *c.* The cervix opposite the os internum; the triangular shape of the uterine cavity is shown, and the dilatation of the cervical cavity with the rugæ termed arbor vitæ. *v.* Upper part of the vagina. *od.* Fallopian tube or oviduct; the narrow communication of its cavity with that of the cornu of the uterus on each side is seen. *l.* Round ligament. *lo.* ligament of the ovary. *o.* Ovary. *i.* Wide outer part of the right Fallopian tube. *fi.* Its fimbriated extremity. *po.* Parovarium. *h.* One of the hydatids frequently found connected with the broad ligament.

gestation; i. e., the retention of the embryo during the term of fœtal life, till it is *viable* apart from the mother.

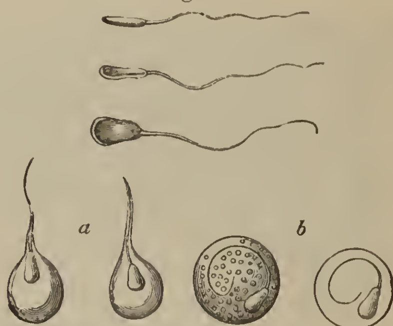
Male Organs of Generation.

The essential organs of reproduction in man are the *testicles.* In the seminal fluid are multitudes of *spermatozoa*, on which its generative potency depends. These are microscopically minute bodies, $\frac{1}{600}$ of an inch long, each with a triangular head and elongated tapering tail; moving incessantly while their vitality continues. This motion, suggesting the idea of animality, gave rise to their name; but they are well understood to be *cell-filaments*, with a motility like that of some other reproductive forms, vegetable as well as animal, but not animalcular themselves. Perhaps each spermatozoon may be a ciliated cell, with but one cilium, the tail.

When the spermatozoa become dry, or are subject to extreme heat or cold, or to disorganizing agents of any kind, they cease moving directly. Otherwise, it is probable that (in the genital organs of the female, for instance, after coitus) they may sometimes retain their vitality for hours, or even days.

Kölliker's account of the formation of the spermatozoa is as follows. At and after puberty, there are formed in the seminiferous tubes of the testicle certain vesicles; each containing from one to twenty nuclei, with nucleoli in them. In these vesicles,

Fig. 178.



SPERMATOZOA.—*a*. Spermatozoa of the squirrel. *b*. Spermatozoa of the dog; two inclosed in the sperm-cells, and three free.

probably from the nuclei, the spermatozoa are developed in bundles. Then the vesicle gives way and disappears, and the spermatozoa are set free in the ducts, with a very small amount of fluid. This mingling of the spermatozoa occurs in the *rete testis* and head of the epididymis.

Fig. 179.

THE BASE OF THE MALE BLADDER, WITH THE VESICULÆ SEMINALES AND PROSTATE GLAND.—1. The urinary bladder. 2. The longitudinal layer of muscular fibres. 3. The prostate gland. 4. Membranous portion of the urethra. 5. The ureters. 6. Bloodvessels. 7. Left, 8. Right vas deferens. 9. Left seminal vesicle in its natural position. 10 Ductus ejaculatorius of the left side, traversing the prostate gland. 11. Right seminal vesicle injected and unravelled. 12, 13. Blind pouches of vesiculæ. 14. Right ductus ejaculatorius traversing the prostate.

Passing through these and the *vas deferens*, a glairy mucus is added, and the material is accumulated in the *vesiculæ seminales*. When the sexual orgasm takes place, contraction of surrounding muscular fibres expels the semen from the vesiculæ seminales into the urethra. There it receives the secretions of the prostate gland, the glands of Cowper, and the mucous follicles of the urethra; all of which are excited together, by the act of coition.

Entrance of the seminal fluid into the uterus is necessary for impregnation. Sometimes certainly, perhaps usually, a portion of it passes through a Fallopian tube to an ovary.

Periodicity in reproduction is observed in many animals. In the human female, monthly ovulation occurs, with the menstrual hemorrhage. Difficulty exists in ascertaining whether any regular periodicity is normal in the male. Observation makes it not improbable that a special proclivity to seminal secretion and discharge exists, in continent persons, about once in two or three weeks. Like the mammary glands in the female, it is known that the testicles may, in the absence of excitation, remain inactive, so as for long periods to be free from discharge, without inconvenience. These organs, however, like others in the body, are excited to secretion by mental and emotional, as well as by physical stimulation.

CHAPTER VI.

MUSCULAR ACTION.

Some account has been given, on a previous page, of the two sorts of muscular tissue; the red, striated, usually voluntary, and the white, non-striated, always involuntary muscle; the former in the limbs, trunk, and face, as well as in the heart; the latter in the alimentary canal, uterus, bladder, middle coat of arteries, gland-ducts, etc. Most of the physiological facts to be stated are true of both kinds, although the voluntary muscle-fibres are always quicker in contraction.

No perceptible change of bulk, but only of shape, occurs when a muscle shortens; as it expands laterally at the same time. This may be seen and felt in many muscles; as, *e. g.*, in the biceps muscle of the arm.

Several *theories* concerning the source or nature of muscular power have been proposed. Haller, long ago, showed that contractility belongs to the muscular tissue itself; not *depending* on the nervous system, though ordinarily called into action under nervous influence. *Electricity* has by many been thought to afford the means of explaining muscular power; the analogy being closest, perhaps, to electro-magnetism, as, that used in the telegraph. Matteucci's and Dubois Raymond's experiments are considered by Dr. Radcliffe to sustain an electrical theory.

Dr. B. W. Richardson has lately urged with emphasis the importance of the direct relation between *caloric* (heat) and muscular power.

Chemical change, similar to that which generates animal heat, all agree in believing to be either a cause or an accompaniment of muscular action. Many physiologists have supposed the change to be disintegration or waste of the *muscle itself*; that the consumption of the muscular tissue might be the source of the power. Some

late experiments seem to contradict this view; especially those of Fick and Wislicenus; who found that, in a day's journey, climbing one of the Alps, there was no decided increase in the amount of nitrogenous waste (measured by the urinary solids) beyond that of repose. It would seem to be the *non-nitrogenous* material of the blood, supplied by food, that is consumed for the production of muscular power. Yet, when exercise is very violent or prolonged, or the supply of food is deficient, the material of the tissues must be called upon to furnish "fuel" for motor force. This was illustrated by the pedestrian Weston; whose excretion of urea was found by Prof. A. Flint, Jr., to be largely increased while he was walking 100 miles in 24 hours.

Only the *contraction* of any muscle is active. Its dilatation is produced sometimes by elasticity, often by opposing muscles. Almost every muscle in the body has its antagonist. So there are, for the limbs, the flexors and extensors; for the fingers, adductors and abductors; at the anus, the sphincter and levator ani, etc. All muscles have, during life, a continued slight *passive* contraction. Since the opposing groups of muscles are not exactly equal in power, the position of the parts of the body when at rest is determined by the preponderance of one or another set; as in the flexion of the fingers during sleep.

After death, for a certain time, the muscles will contract under the excitation of galvanic electricity. The signal of the loss of this irritability is the coming on of *rigor mortis*, the stiffening of death. This is not a vital contraction at all, but rather a physical change, the first result of the death of the muscle. Perhaps it depends upon a coagulation of the inter-fibrillary fluid. Experimentally, it has been found (Brown-Séquard) that injection of arterial blood into muscles of the dead body will retard the rigor mortis, and prolong the time of irritability of the muscles under galvanic excitation. After it, follow relaxation and decomposition.

Rigor mortis may begin at any time from ten minutes to six or seven hours after death; usually it is an hour or two at least. Sudden death from violence in full health is followed by *late* rigidity, continued long. After protracted exhausting disease, it is apt to occur soon and to be short in duration. Death by lightning has been sometimes observed to be without any rigor mortis.

This stiffening affects the involuntary as well as the voluntary muscles. It begins in the left ventricle, and ends in the right auricle; the other muscular organs, including the arteries, contracting between these extremes in time.

Classifying the muscles of the body according to their method of action, they may be designated as *voluntary*, *involuntary*, and *mixed*. Purely voluntary are all the muscles of the surface of the trunk and of the extremities.

Voluntary Muscles.

The action of these, by their tendinous attachments, is, in most cases, upon the bones. The latter, as mechanical instruments of locomotion, may be divided into levers of the *first*, *second*, and *third* kinds. In the first, the *fulcrum* or fixed point is between the power applied and the weight or resistance. In the second, the

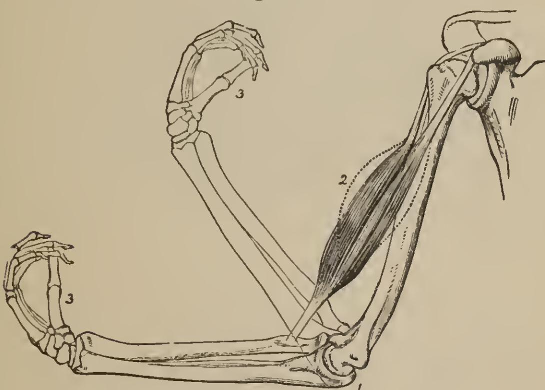
weight or resistance is between the power and the fulcrum. In the third, the *power* is applied between the fulcrum and the weight or resistance.

Of the first kind of lever, an example is seen in the movement forward, or backward, of the head upon the spine, by the muscles of the front or back of the neck.

Of the second kind, an instance is, raising the body upon the toes, by the action of the muscles of the calf of the leg.

Of the third kind, the action of the *biceps flexor cubiti* is the best example. In this, the power is applied at the insertion of the biceps tendon into the radius, below the elbow; the fulcrum is at the elbow-joint, and the weight is that of the forearm and hand.

Fig. 180.



THE BICEPS MUSCLE.—1. The fulcrum. 2. The power. 3, 3. The weight.

This muscle affords an illustration of the fact that some muscles are arranged at a less advantage of *power* than might be given by a different insertion. If the biceps were inserted at the wrist, it would lift ten times as much. But, then, inconvenience in bulk and loss of beauty and grace in action would follow. The law of mechanics also applies, that what is gained in power is lost in velocity, and *vice versâ*.

Pulleys for special direction of muscular action exist in several parts of the body; as in the course of the *superior oblique* muscle of the eye, the *digastric* of the neck and lower jaw, etc.

The amount of effort made by the muscles is perceived by what is called the *muscular sense*. Its employment is exemplified in *weighing* anything in the hand, in balancing one's self (à la Blondin) on a tight rope, and in skating. The latter exercise is guided almost entirely by the muscular sense.

Involuntary muscular action has been considered sufficiently, in connection with the organs of nutrition, secretion, etc., whose functions it subserves.

Mixed Muscles.

Of this character are the muscles of the pharynx, of the respiratory apparatus, and of the face.

When we *swallow*, the will has control only over the beginning of the process; after the morsel gets fairly within the grasp of the constrictor muscles, its descent cannot be arrested.

Breathing is ordinarily involuntary, continuing during sleep. But we have the power to hold the breath for some seconds, as well as to modulate it for vocal utterance.

The muscles of *expression*, in the face, though yielding readily to volition, are most naturally controlled by *emotion*. Strong feeling involuntarily exhibits itself in the countenance. Efforts at the expression, by the face, of counterfeit emotion, when no feeling exists, seldom are successful. Actors and orators personate and convey emotion best, by throwing themselves for the time into the character or feeling required; so that it then expresses itself, naturally and effectively.

Many muscular movements which at first are performed entirely under direction of the will, by frequent repetition become habitual, and then involuntary. Walking is an act of this kind. Soldiers, on long marches, have, it is said, sometimes fallen asleep on the road, yet continued marching. An expert musician is said to have finished playing a piece on the piano, begun while awake, after going to sleep.

CHAPTER VII.

FUNCTIONS OF THE NERVOUS SYSTEM.

GENERAL CONSIDERATIONS.

The purpose of the nervous apparatus, still more constantly than that of the muscular system, is to maintain *relations* and *communications* between the body and things external to it, and between its own different parts.

The ultimate formative elements of the nervous system are, 1, *nerve cells*, collected into *ganglia* or *nerve-centres;* and 2, *tubular nerve-filaments*, arranged in bundles called nerves and commissures. The centres are like the stations or offices of a telegraphic system; the nerves correspond with the wires. The simplest conceivable nervous system consists of one ganglion with two nerves; one of these conveying impressions from the surface to the ganglionic centre, and the other taking out impressions from that centre to a movable tissue. The first of these nerves is called an *afferent*, and the second an *efferent* nerve. Action produced by such a conveyance and *reflection* of an impression by a nerve centre is called *excito-motor* or *reflex* action.

Ganglia are said to receive, accumulate, generate, reflect, and radiate nerve-force. Most certain is the fact of their *reflection* of

impressions; the understanding of which is the key to the functions of nervous organs, from the lowest to the highest. *Radiation* of impressions appears to occur sometimes, as when disease in one tooth causes pain in the whole of that side of the face; or when inflammation of the hip-joint (coxalgia) brings on pain extending to the knee.

Fig. 181.

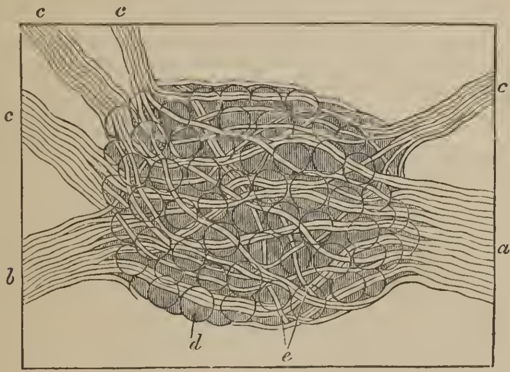


DIAGRAM OF GANGLION.—*a*, *b*, *c*. Nerves. *d*, *e*. Cells.

Nerves only transmit impressions. Their analogy to wires of the telegraph is close; we do not understand that anything "flows" along them, the term *current* being metaphorical; but, that a *wave* of *movement* of their particles is propagated along them, from end to end. Certain constant facts or laws of nervous transmission are important.

1. Every nerve transmits impressions *only in one direction;* either toward (afferent) or from (efferent) a centre. All afferent nerves are not sensory. Reflex action may occur without sensation. The latter only exists when an impression is conveyed to the *brain*, the seat of the perception of sensations.

There is clear proof that muscular movement may take place without sensibility of the parts concerned. Thus, in the experiment of Brown-Séquard and others, of dividing the spinal marrow of a frog in sunder; if a hind foot of the animal be then pinched, the limb will be jerked with force; although it is certain that no sensation can be conveyed to the brain. John Hunter saw a paraplegic patient, quite deprived of feeling in his feet; yet tickling the sole of one of them caused the limb to be withdrawn. This was *involuntary*, *automatic*, reflex or excito-motor action.

2. Each nerve can convey only *one kind* of impression. *Efferent* nerves may be nerves of *motion*, if they are distributed to muscles; or, the excitation they bear out will cause *secretion*, if they terminate in glandular organs. This, when it results from an impression reflected by a ganglion which receives it from an impressible (exterior or interior) surface, is *excito-secretory* action. So, the

presence of food in the mouth excites the salivary glands to secretion; in the stomach, it draws out the secretion of the gastric juice, etc. Morbidly, we find the irritation of the gums in the dentition of weakly children inducing diarrhœa, from excessive excito-secretory action. This is parallel to the violent morbid *excito-motor* action, denominated *convulsions*, which incomplete dentition may cause, through irritation of the spinal marrow; and which may also be brought on, in like manner, by the presence of indigestible food in the stomach or intestines, or accumulated feces in the rectum. The term *trophic* nerves is sometimes applied to such as are supposed to exercise immediate control over nutrition.

Nerves of *sensation* are capable, each, of only one kind of sensibility. Some are nerves of *touch*, one of *sight*, another of *hearing*, *taste*, or *smell;* no one of *more* than one of these. If the optic nerve is irritated, a flash of light, not pain, results. Irritation of the auditory nerve or its sensorial centre will cause a "subjective" impression of sound: as, for example, the "tinnitus aurium" produced by quinine in large doses. Substitution of the guidance of one sense by that of another may occur, as when a blind person walks by direction of his hearing and touch. But the actual transfer of one kind of special sensibility to a nerve possessed naturally of another function, is impossible. The sense of *temperature* is regarded by some as different from that of touch.

3. Sensory nerves usually report, so to speak, their impressions as if coming from their terminations; even when it is the trunk of the nerve that is acted upon. What is commonly called the *crazy-bone* at the elbow is the ulnar nerve; when it is struck, the principal pain is not at the elbow, but in the last two fingers, to which its terminations are distributed. After the amputation of a limb, sometimes sensations in the stump seem to the patient to be in the missing toes. A flap of skin being brought over the nose to replace a deficiency of the latter, for a few days a fly lighting on the nose will produce an itching, referred in the individual's feeling to his forehead. The *velocity* of transmission of nerve-impressions has been variously estimated by different observers at from 90 to 140 feet in a second of time.

Nerve filaments never inosculate (*i. e.*, actually join into one, as bloodvessels do), although they are often packed together in the same trunk, called "a nerve." When such a trunk is divided, intentionally or by accident, it is slow to unite again. In course of time it will do so, however, and then the function of its filaments may be, though it is not always, entirely restored. This is remarkable, since a trunk, containing a number of filaments, some motor, some sensory, and others ganglionic or sympathetic, must, when divided, suffer displacement of their corresponding ends. Each filament must, therefore, be restored to its proper connection, notwithstanding the displacement; as though function had a sort of control over nutrition.

Nothing in the appearance or structure of any nerve shows a reason for its character, *i. e.*, whether it be sensory or motor, etc. This would seem to be determined by the connections of its extremities. Dr. Beale believes that no nerves have free ends; but that each filament makes a complete circuit. Kölliker asserts that

free ends exist in the terminations of nerves in the muscular fibres. Fine *plexuses* are also observed in the muscles; and sometimes little *end-plates*, partly of connective tissue. Ganglionic *cells* are attached to the peripheral extremities of nerve-filaments, in the retina, and in the internal ear. The *neuroglia* is a fine network of peculiar (connective) tissue extending through both the ganglionic and the filamentous distribution of nervous substance, giving it coherence and support.

The nature of nerve-force has been the subject of much speculation. The favorite hypothesis with many has been, that it is identical with electricity. Galvanism will, undoubtedly, *stimulate* the muscles and other organs through the nerves of a living or recently dead animal. But so also will the point of a knife, high heat, a drop of nitric acid, etc. Electricity is only one of the stimulants which call out, as it were, nerve-force. Moreover, Matteucci has shown that no special electrical current passes through even the largest nerve of the limb of a horse, when the muscles are stimulated to action. If a nerve be cut across, and the ends be placed in contact, or with a copper wire between them; or if a ligature be drawn tightly around it; in either case electricity will traverse it freely, but nerve impressions will not. Muscle is a decidedly better conductor of electricity than nerve; and copper wire is many million times a better conductor than either. Still, electrical currents are proved to be constantly present in different parts of the living body. Among the conversions or transmutations of force (modes of motion) taking place, it is quite probable that the generation of electricity may have a place, not as yet clearly defined. This is rendered the more probable by the fact that several species of fish, as the *torpedo*, *gymnotus*, and *silurus*, have special electrical organs or batteries, directly connected in each with the nervous system.

REFLEX ACTION.

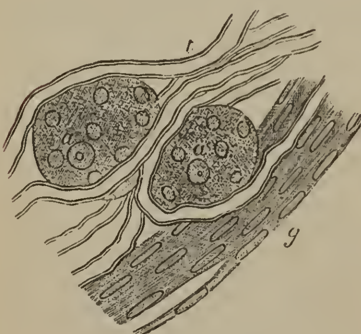
This is the key to the whole physiology of the nervous system. Although before discerned by Unzer and other physiologists, to Marshall Hall belongs the credit of developing our knowledge especially of the reflex functions of the spinal marrow. Laycock, Carpenter, and others have extended the study of reflex action to the physiology of the brain and of mental action; Longet and Campbell, into that of the secreting organs. The simplest and most common of reflex actions, in all the subdivisions of the animal kingdom, is *excito-motor* action. Next, is *excito-secretory* action. We may add, after Carpenter, *sensori-motor* and *ideo-motor* actions. Besides, also, the *voluntary* motor actions, wherein will directs the choice between different possible actions of the reflex system, it would be equally correct to speak of *emoto-motor* actions; in which, not volition, but emotion gives character to the effective impulse.

Excito-motor actions are those in which an impression upon a receptive surface (interior or exterior) is, by an afferent nerve, conveyed to a motor nerve-centre, and thence reflected through an efferent (motor) nerve to a muscle, which it brings into action.

Thus, in a complex animal, movements are effected by stimuli at a distance from the muscles, which could not, without inconvenience, be made to reach them directly. In this way the nerves and nerve-centres are *internuncial* in the body itself.

Familiar acts give clear examples of such reflex agency. The pupil of the eye contracts when strong light falls upon the retina; this is because the impression is conveyed to a ganglionic centre, and thence reflected through a nerve to the circular muscular fibres of the iris. The impression of the want of oxygen in the blood is conveyed (chiefly from the lungs by the pneumogastric nerve) to the medulla oblongata; thence it is reflected, as a motor impulse, to the diaphragm and intercostal muscles, for inspiration. A morsel of food is introduced into the pharynx; the impression made by it upon the mucous membrane is carried by the glosso-pharyngeal nerve to a part of the medulla oblongata, whence it is reflected to the constrictor muscles of the pharynx which act in deglutition. A similar account might, of course, be given of defecation, parturition, etc.

Fig. 182.



GANGLION-CELLS.

Excito-motor actions under *morbid* irritation are seen in convulsions, lock-jaw (trismus, tetanus), and, with less violence, in coughing, sneezing, vomiting. Such movements are usually involuntary, and often not controllable by the will. *Extreme* reflex excitability is met with especially in infancy (most of all during dentition), and in *hysteria* and *hydrophobia*.

GANGLIONIC NERVOUS APPARATUS.

In *Anatomy* this is commonly described as "the Sympathetic Nerve." All the ganglia upon the spinal column and in the cavities and internal organs of the body, have two sets of communications; 1, with the spinal cord; 2, with the organs of circulation, digestion, assimilation, secretion, or reproduction.

Whether any motor or other power belongs to or originates in the ganglia, or whether all their energy is derived from the spinal marrow, is a question. At all events they exercise a modifying, regulating influence over the functions of the organs to which, in many parts, they alone send nerves. This is the case with the arteries, intestines, glands and their ducts, etc. Bernard and others have shown, for instance, that division of the sympathetic nerve in the neck causes passive dilatation of the bloodvessels, with redness and heat.

A question exists, also, whether, in each of these instances, the "sympathetic" ganglia control and regulate the organic functions, only by their influence over the action and calibre of the *blood-vessels*, or by a more *direct* power exerted over secretion and

Fig. 183.

JUNCTION OF SPINAL AND SYMPATHETIC SYSTEMS.—*a*. Anterior root of spinal nerve. *p*. Posterior root. *c*. Columns of spinal cord. *s*. Sympathetic. *a'*. Spinal nerve. *e*. Connecting filaments.

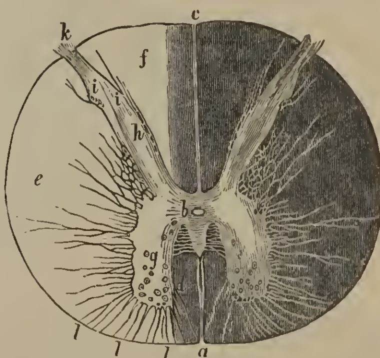
nutrition. Much has been made recently (especially in the *neuropathy* of Dr. John Chapman) of the vaso-motor action of the ganglia, and the modifications of it produced by temperature, etc. Pflüger's experiments, however, clearly demonstrate that the nerves exert an influence over the secretory action of glands *apart from*, or over and above, that belonging to changes in the circulation of the blood. These changes, also, are, no doubt, important.

SPINAL MARROW.

Consisting of a central ganglionic mass, inclosed in columns of white nerve-substance, the functions of the spinal cord are complex. After Magendie had demonstrated that different nerves going to the same parts may have different functions, Sir Charles Bell

extended this discovery to the roots of the spinal nerves. He proved that the *posterior* roots are entirely *sensory*, or afferent, and the *anterior* roots exclusively *motor*. This is shown by the fact that, when a posterior root alone is divided in a living animal, irritation of the end left in connection with the spinal cord will produce signs of pain; while irritation of the distal end will cause no result. On the contrary, if an anterior root be cut across, irritation of the end next the spinal marrow will produce no effect; but excitation of the end connected with the muscles will throw them into action. Beyond their roots, the spinal nerves are mixed, containing both sensitive and motor filaments.

Fig. 184.



SECTION OF SPINAL CORD.—*a*. Anterior fissure. *b*. Gray central substance. *c*. Posterior fissure. *e*. *f*. White substance. *k*. Posterior nerve-root. *l*, *l*, *l*. Anterior filaments.

Part of the functional use of the spinal cord is, to transmit impressions, sensory and motor, to and from the brain. This is effected both by the white and the gray substance; principally, it may be supposed, by the former. A difference in function between the anterior and posterior *columns* of the cord has been proved. The *anterior* columns, under excitation, emit motor impulses through their motor nerves, producing action of muscles. The *posterior* columns, when irritated, display sensibility instead.

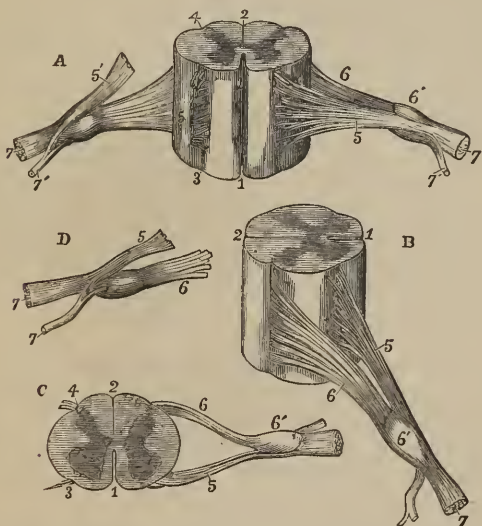
Crossing or *decussation*, however, occurs in the cord. The *anterior* columns decussate at the medulla oblongata, just within the skull. Therefore, disease of the brain (apoplexy, compression from fracture, etc.) on one side, commonly produces paralysis of motion on the other side of the body; as, in many cases of what is called *aphasia*,[1] disease of the left side of the brain is attended by right hemiplegia, *i. e.*, palsy of the right half of the body.

Brown-Séquard has inferred from his experiments that the *sensory* filaments of the spinal cord cross each other through the *whole*

[1] Loss of language, from cerebral disorder.

length of the cord. The same physiologist asserts, that the sensory filaments of the spinal nerves, after entering the posterior columns, pass *through* them, and terminate in the *gray central* portion of the other side of the cord. Therefore, if the posterior columns be alone divided in any part of the cord, sensibility is not destroyed in all the nerves below that part, but only in those which enter near the place of division.

Fig. 185.



DIFFERENT VIEWS OF A PORTION OF THE SPINAL CORD FROM THE CERVICAL REGION, WITH THE ROOTS OF THE NERVES SLIGHTLY ENLARGED.—In A, the anterior surface of the specimen is shown, the anterior nerve-root of its right side being divided. In B, a view of the right side is given. In C, the upper surface is shown. In D, the nerve-roots and ganglion are shown from below. 1. The anterior median fissure. 2. Posterior median fissure. 3. Anterior lateral depression, over which the anterior nerve-roots are seen to spread. 4. Posterior lateral groove, into which the posterior roots are seen to sink. 5. Anterior roots passing the ganglion. 5′. In A, the anterior root divided. 6. The posterior roots, the fibres of which pass into the ganglion 6′. 7. The united or compound nerve. 7′. The posterior primary branch, seen in A and D to be derived in part from the anterior and in part from the posterior root.

Besides thus acting as a medium of communication between the brain and all parts of the body except the head and face, the spinal marrow has more special functions of its own, as the seat of reflex actions. The drawing away of a limb when it is touched by anything very hot or very cold, or pinched, is often entirely involuntary. It may happen during sleep, or when, from paralytic disease, the part is incapable of sensation. The spinal cord seems,

here, to be capable of maintaining action independently of the brain. This has, also, been abundantly proved in decapitated animals.

The habitual passive action of the muscles, though perhaps resulting in part from the essential nature of living muscle, is under the *influence* of the spinal marrow; as shown in an experiment by Wilson Philips. He found that, when a red-hot iron rod was suddenly thrust through the whole length of the spinal cord, all the muscles became relaxed at once.

The *sphincter* muscles, which guard the outlets of the rectum and bladder, are kept in due contraction under the influence of the spinal marrow. Its reflex agency is also, no doubt, concerned, differently, in the evacuation of the rectum and bladder; in order for which, the contraction of the sphincters yields to dilatation under expulsive effort. Ordinarily, the will can control and regulate these actions.

If the spinal marrow be seriously injured low down, loss of power over the sphincters results; and involuntary defecation, retention, and incontinence of urine follow. If high up, disturbance of the secreting organs occurs, from the influence of the spinal cord over the ganglia. Injury of the spine in the neck, as high as the third vertebra, is almost always fatal at once, by interruption of respiration; to which a sound state of the phrenic and intercostal nerves is essential.

ENCEPHALON OR BRAIN.

All the contents of the cranium, together, constitute the *encephalon;* the average weight of which to the whole body, in man, bears the proportion of about 1 to 36. In mammals (animals which suckle their young) as a class, the average proportion of brain to body is 1 to 186.

The *parts* of the encephalon are, the *medulla oblongata* and *pons Varolii*, the *cerebellum*, and the *cerebrum*. Further subdivision of these, of course, may be made, upon both anatomical and physiological grounds. If the whole encephalon were divided into 204 equal parts, the cerebral hemispheres would make of these 170 parts, the cerebellum 21, the medulla oblongata, corpora striata, and thalami 13 parts. On the same scale, the spinal cord would weigh 7 parts. The comparative size of these different portions of the nervous system is very different in different animals.

Medulla Oblongata.

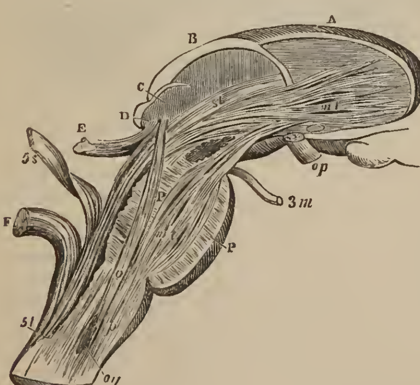
Although several nerves of different functions begin or terminate about the place of union of the medulla oblongata with the base of the brain, the peculiar attributes of this centre are connected with respiration and deglutition. It is the seat of the reflex actions essential to those functions; the performance of which is, in its nature, spinal, while, for obvious reasons of convenience, they are both voluntary to a certain degree. For speech, we must have some control over the expiratory muscles; and so we must be able to manage those used in swallowing, on various occasions.

Fig. 186.

DIAGRAM OF ENCEPHALON.—*A.* Cerebrum. *B.* Cerebellum. *C.* Sensori-motor tract. *D.* Medulla oblongata. *E.* Spinal cord. *a.* Olfactory nerve. *b.* Optic. *c.* Auditory. *d.* Pneumogastric. *e.* Hypoglossal. *f.* Spinal.

Because of its being the centre presiding over respiration, the functional activity of the medulla oblongata is, in man and all the

Fig. 187.



MEDULLA OBLONGATA.—*A.* Corpus striatum. *B.* Thalamus. *C, D.* Corpora quadrigemina. *E.* Commissure. *F.* Corpora restiformia. *P, P.* Pons Varolii.

higher animals, indispensable to life. Mechanical injury or disease affecting it considerably, or narcotism of it by large quantities of chloroform, etc., is fatal. Ludwig asserts that the medulla oblongata contains the chief *vaso-motor* centre; *i. e.*, that from which an influence goes out (through the ganglionic nerves finally) which controls the degree of contraction of the bloodvessels. But this cannot be considered as yet to have been proven.

The *pons Varolii* or tuber annulare is, in its greater part, commissural; *i. e.*, connective, between the two halves of the cerebellum, and, by a small number of its filaments, passing also into the two hemispheres of the cerebrum. A mass of gray vesicular nervous matter, however, is imbedded within it; which Longet and others believe to be "the ganglion by which impressions, conveyed inward through the nerves, are first converted into conscious sensations; and in which the voluntary impulses originate, which stimulate the muscles to contraction."[1]

Cerebellum.

Gall, the founder of the system of phrenology, proposed the opinion, founded upon a few coincidences, that the cerebellum is the seat of "amativeness," or the sexual propensity. Investigation has not sustained this view. Upon any such question, three principal methods of inquiry are open: 1, comparison of structure and function in different animals; 2, the results of disease or injury; 3, experiments upon living animals. Flourens, Longet, and others have, on the basis of the experimental method, proposed the theory, that the cerebellum has the duty of co-ordinating, or harmonizing together, voluntary muscular movements. A bird or animal from which the cerebellum has been removed, loses the power to regulate its movements—like one intoxicated.

Fig. 188.

CEREBELLUM.—*m.* Medulla oblongata. *c.* Pons Varolii. *w.* Hemispheres of cerebellum. *i.* Middle notch. *p.* Pyramids. *e, e.* Crura. 3 to 7. Nerves.

Disease of the cerebellum has not often been, after death, shown

[1] Dalton's Physiology, p. 423.

to have been connected with special symptoms; but some instances have occurred, which at least do not oppose the above theory.

Comparison of the structure of the brain, and the corresponding endowments, of different animals, is, upon this as on other allied topics, the most instructive method. No relation appears between the size of the cerebellum and the sexual appetite. It is large, comparatively, in some animals (fishes) which do not copulate; and proportionately small in some, as the frog, in which the propensity is powerful. With locomotor activity, and especially *complexity* of movements, there does appear to be proportionate development of the cerebellum. So, in birds of rapid and varied flight, as the swallow and many birds of prey, it is large, while in the polygamous but heavily flying pheasant family, of which the common barn fowl is a member, it is small. The climbing ape has it quite large. The bear, which stands naturally on two feet, using the other two as hands, has a larger cerebellum than the dog, to which that position is unnatural. Lastly, removal of the testicles early in life does not, in the horse, at all lessen the growth of the cerebellum, if the animal is kept at work; that of the gelding, at full maturity of age, is often larger than that of the stallion or the mare. Altogether, the evidence is sufficient to make the theory of Flourens much the most probable. Perhaps the cerebellum may also be the seat of the muscular sense of Sir Charles Bell. Dr. S. Weir Mitchell found that in animals kept alive for several months after removal of the whole of the cerebellum, the co-ordination of muscular actions was gradually restored. This seems to suggest either that the cerebellum is only the principal *one* of the central seats of the co-ordinative function, or else that it may be rather a *reservoir* of *motor force*. Some experiments of Drs. B. W. Richardson and S. Weir Mitchell in *congealing* different parts of the brain in animals by jets of ether spray, have been interesting, but their results are not yet sufficiently definite for positive conclusions.

Sensorial Ganglia.

Anatomically, sufficient distinction exists for naming under this category, the *corpora striata*, *thalami*, and *tubercula quadrigemina*. Physiological reasons suggest the propriety of recognizing the association with these, of those other small ganglionic masses in which terminate the nerves of hearing, smell, and taste.

Experiments point to the *corpora striata* as the probable source from which emanate the *motor impulses* of muscular actions. Like evidence exists for the view that

Fig. 189.

LONGITUDINAL SECTION OF THE BRAIN.—*a*. Right hemisphere of cerebrum. *c*. Corpus callosum. *d*. Cerebellum, showing *arbor vitæ*. *e* Medulla oblongata. *f*. Spinal cord.

the thalami (formerly called *nervorum opticorum*) are the receptacles of impressions of *common sensation* or touch. Each *corpus striatum* is *anterior* to the corresponding *thalamus;* being thus continuous, the former with the anterior columns, and the latter with the posterior columns, of the spinal marrow.

The *tubercula quadrigemina* are the principal terminations of the *optic nerves;* the latter, however, sending filaments also to the thalami.

The reason for the close contiguity and connection between these different sensorial centres, and between them and the corpora striata, as well as between them and the spinal marrow below and the cerebral hemispheres above, is explained by the facts of what is called *sensori-motor guidance.* Every voluntary action is guided by a sensation; walking, speaking, writing, playing upon an instrument, working with tools. If one shuts his eyes and tries to walk a plank, he will almost certainly fall. Even the disturbance of vision which attends looking down from a great height may render walking dangerous, though otherwise safe. All confused or unusual impressions make actions uncertain. *Mutes* are commonly so because born *deaf.* Those who become deaf after learning to talk, retain speech. For musical performance, one must have a good *ear;* for painting or sculpture, good visual perception and discernment.

Some sensori-motor (reflex) actions are involuntary; as winking, sneezing. Common acts, as walking, may become so, when habitual, though at first requiring attention and will. Blind persons exemplify the guidance of divers sensations; instead of sight, they walk by hearing and touch. Sensori-motor actions under morbid causes often occur; as coughing, vomiting, hysterical convulsions. *Instincts* are, usually, sensori-motor impulses and actions, more or less voluntary.

Cranial or Cephalic Nerves.

Anatomists still mostly number these as nine on each side. Functionally, a very different classification might be made out. The more common enumeration (that of Willis) is contrasted with that of Sœmmering in the following table:—

WILLIS.	SŒMMERING.	NAME.
I. to VI.	I. to VI.	(The same in both.)
VII.	VII.	Facial (portio dura).
	VIII.	Auditory (portio mollis).
VIII.	IX.	Glosso-pharyngeal.
	X.	Pneumogastric.
	XI.	Spinal accessory.
IX.	XII.	Hypoglossal.

Comparing them, in plan of arrangement, to the spinal nerves, Dr. Dalton gives the following table:—

CRANIAL NERVES.

NERVES OF SPECIAL SENSE.

1. OLFACTORY. 2. OPTIC. 3. AUDITORY.

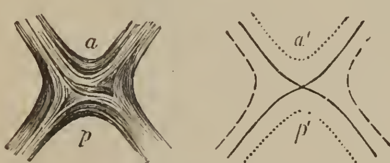
	Motor Nerves.	*Sensitive Nerves.*
1st Pair	Motor oculi communis Patheticus Motor oculi externus Small root of 5th pair Facial	Large root of 5th pair.
2d Pair	Hypoglossal.	Glosso-pharyngeal.
3d Pair	Spinal Accessory.	Pneumogastric.

Following the common enumeration, the functions of the different nerves may be briefly described :—

1*st pair*. *Olfactory nerve.*—Peculiar in having a bulb at its anterior extremity, which is apparently the true ganglionic portion.

2*d pair*. *Optic nerve.*—Remarkable for the *chiasm* or union of the two optic nerves, by which an entire unity of the visual image is produced, from the two actual images, one on each retina.

Fig. 190.



CHIASM OF OPTIC NERVES.

3*d pair*. *Motor oculi communis.*—All the muscles of the eyeball (four *recti* and two *obliqui*) are supplied by this nerve ; also, the *levator palpebræ*, and the *iris*. Besides the simple ordinary movements of the eyeball, therefore, the opening of the eye and the contraction of the pupil are controlled by it.

4*th pair*. *Patheticus.*—Only the superior oblique muscle is supplied with motor influence by this nerve.

6*th pair*. *Motor externus.*—The external rectus muscle of the eyeball receives all the terminations of this. It is sometimes called *abducens oculi.*

7*th pair*. *Portio dura ; Facial nerve.*—This is the *motor* nerve of the superficial muscles of the face ; including the orbicularis oculi. When it is paralyzed, which happens sometimes from exposure to cold, the lower eyelid falls, and so does the corner of the mouth ; and all expression of that side of the face is lost.

The sensibility which belongs to some branches of this nerve over the face is derived entirely from the union in the same sheaths of filaments from the *fifth* nerve ; the seventh is altogether motor ; unless to its own filaments be ascribed an influence upon secretion, through small branches going to the parotid and submaxillary glands. The flow of tears over the face, observed in some in-

stances of paralysis of the facial nerve, is due to the loss of tension of the *tensor tarsi* (Horner's) muscle, and consequent obstruction of the *puncta lachrymalia.* The impairment of taste sometimes attending paralysis of the seventh nerve, has not been fully explained.

Portio mollis of 7th pair; *Auditory nerve.*—To this belongs exclusively the conveyance of impressions of sound from the ear to the base of the brain.

9th pair. Hypoglossal.—Being distributed to the tongue, this is the *motor* nerve of that organ.

Having thus disposed, for the present, of the simpler nerves of the series, the *complex* ones remain to be considered. They are the 5th and 8th.

5th pair. Trifacial, or Trigeminus.—Like the spinal nerves, the 5th has two roots; an anterior, smaller, motor, and a posterior larger, sensory root. The latter also has a ganglion upon it, the ganglion of Casser.

After the ganglion, the trunk of the nerve divides into three branches. Of these, the *ophthalmic* (supra-orbital, etc., see *Anatomy*) and *superior maxillary* are entirely sensory; to them being due the sensibility of the upper parts of the face. The inferior maxillary receives all the filaments of the anterior *motor* root of the 5th, besides sensory filaments like the other branches. It supplies the *muscles* of *mastication;* including the buccinator. One branch of the inferior maxillary (lingual nerve) is one of the two nerves of *taste;* going to the tip of the tongue.

The 5th nerve is, perhaps, the most acutely sensitive in the body. Injuries of it produce an indirect disturbance of nutrition; the exact rationale of which has not been entirely explained. *Reflex* symptoms sometimes follow irritation of its branches; as, when a severe blow over the supra-orbital notch causes sympathetic blindness (Morgagni); or a mis-fitting artificial tooth brings on convulsions (Lederer). *Tic douloureux*, or neuralgia of the face, is an affection of the 5th pair.

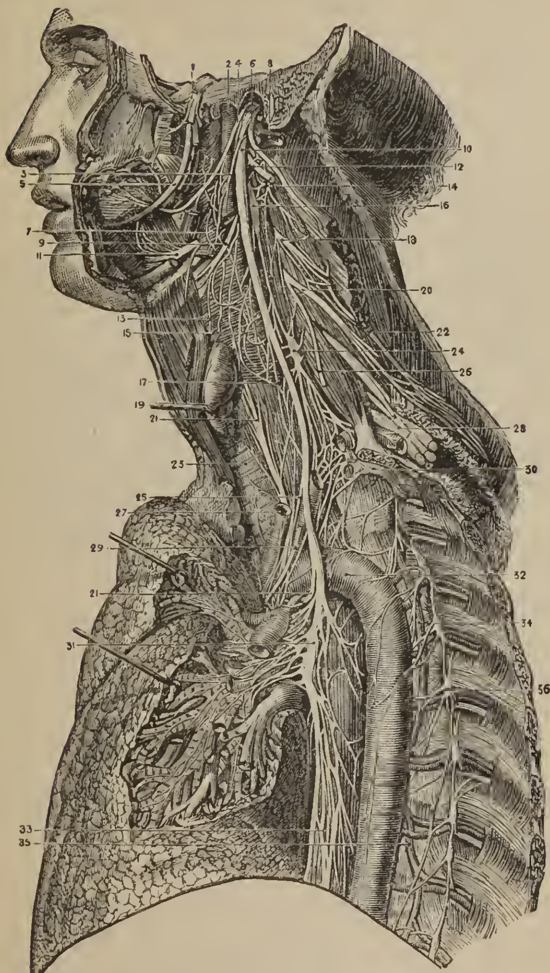
8*th pair.*—Three really separate nerves are included under this; the *par vagum* or *pneumogastric*, the *glosso-pharyngeal*, and the *spinal accessory.*

Pneumogastric nerve.—Although mostly sensory, or at least *afferent*, some motor influence seems to belong to this nerve. The latter is chiefly derived from filaments contributed by the spinal accessory; as such enter into the pharyngeal branch, and into the *inferior laryngeal* branch of the par vagum, which supplies the vocal muscles. The *superior* laryngeal is a sensitive nerve.

The pneumogastric is the main afferent nerve of respiration; by which the impression of the need of fresh air (*besoin de respirer* of the French) is transmitted from the lungs to the medulla oblongata. Probably, however, other nerves may contribute to the same end, by conveying to the same respiratory centre an impression of the need of air from all parts of the body.

Digestion is also to some extent under the influence of the same nerve. When one pneumogastric is divided in a living animal, near the stomach, its digestion is interrupted. After some days, however, it may recover from the injury, and digest as before. If,

Fig. 191.



Distribution of the Eighth Pair of Nerves on the Left Side.—1. Gasserian ganglion of 5th nerve. 2. Internal carotid artery. 3. Pharyngeal branch of pneumogastric. 4. Glosso-pharyngeal nerve. 5. Lingual nerve (5th). 6. Spinal-accessory nerve. 7. Middle constrictor of pharynx. 8. Internal jugular vein (cut). 9. Superior laryngeal nerve. 10. Ganglion of trunk of pneumogastric nerve. 11. Hypoglossal nerve (cut) on hyoglossus muscle. 12. Ditto (cut) communicating with eighth and first cervical nerve. 13. External laryngeal

nerve. 14. Second cervical nerve looping with first. 15. Pharyngeal plexus on inferior constrictor. 16. Superior cervical ganglion of sympathetic. 17 Superior cardiac nerve of pneumogastric. 18. Third cervical nerve. 19. Thyroid body. 20. Fourth cervical nerve. 21, 21. Left recurrent laryngeal nerve. 22. Spinal-accessory communicating with cervical nerves. 23. Trachea. 24. Middle cervical ganglion of sympathetic. 25. Middle cardiac nerve of pneumogastric. 26. Phrenic nerve (cut). 27. Left carotid artery (cut). 28. Brachial plexus. 29. Phrenic nerve (cut). 30. Inferior cervical ganglion of sympathetic. 31. Pulmonary plexus of pneumogastric. 32. [Arch of the] thoracic aorta. 33. Œsophageal plexus. 34. Vena azygos superior. 35. Vena azygos minor. 36. Gangliated cord of sympathetic.

then, that of the other side be also cut, digestion is more seriously interfered with, and for a longer time; but, at length, before either of the nerves has reunited, the functional action of the stomach is restored. These facts show, that, while the pneumogastric nerve has an *influence* over the digestive process, it is not *essential* to it.

How the *heart* is affected by the normal functional action of the pneumogastric is a difficult question. Vivisection has introduced a problem concerning it. When, in a living animal, the chest is opened, and the pneumogastric divided, if a *powerful* galvanic current be made to act on the end of the nerve towards the heart, that organ ceases to beat almost at once. Two theories have been proposed to explain this. One, that of *inhibition;* namely, that it is the function of the pneumogastric to *check* or *retard* the heart's action. The other, that, since it is only a very strong current of galvanic electricity that will arrest the heart's action, this result is produced by *exhausting* or overwhelming the heart by excessive irritation. The latter is probably true.

Glosso-pharyngeal nerve.—As indicated by its name, this is distributed to the tongue and pharynx. It is doubtful whether a motor function belongs to any of its fibres. It is the afferent nerve of deglutition, and the general sensory nerve of the pharynx. One branch of it is a nerve of *taste;* being distributed to the base and middle of the tongue, and to the soft palate.

Spinal accessory nerve.—The two branches of this, *external* and *internal*, are of separate origins. The *internal* branch comes from the medulla oblongata, and is distributed to the vocal muscles of the larynx; being their motor nerve. The *external* branch comes from the spinal cord, enters the cranium by the foramen magnum—and, going out with the internal branch, is distributed to the *sterno-cleido-mastoid* and *trapezius* muscles. It has only motor functions.

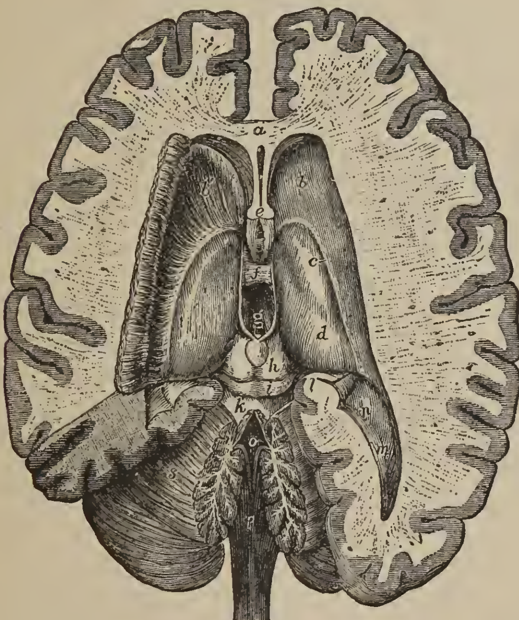
9th pair; hypoglossal nerve.—This is the motor nerve of the tongue. A branch goes to the thyro-hyoid muscle; and the *descendens noni* branch supplies the sterno-hyoid, sterno-thyriod and omo-hyoid muscles. Filaments also go to the submaxillary gland. It appears to be altogether a motor nerve.

Cerebral Hemispheres.

A marked peculiarity of the brain, besides the proportionately large supply of blood which it receives, is, the *variation* in the flow of blood through it from time to time, according to the

presence or absence of mental excitement. As, however, a certain degree of increase of *pressure* will arrest the functions of the

Fig. 192.



Dissection of Brain, from above, exposing the Lateral, Fourth, and Fifth Ventricles, with the Surrounding Parts. ⅔.—*a*. Anterior part, or *genu* of corpus callosum. *b*. Corpus striatum. *b'*. The corpus striatum of left side, dissected so as to expose its gray substance. *c*. Points by a line to the tænia semi-circularis. *d*. Optic thalamus. *e*. Anterior pillars of fornix divided; below they are seen descending in front of the third ventricle, and between them is seen part of the anterior commissure; in front of the letter *e* is seen the slit-like fifth ventricle, between the two laminæ of the septum lucidum. *f*. Soft or middle commissure. *g* is placed in the posterior part of the third ventricle; immediately behind the latter are the posterior commissure (just visible) and the pineal gland, the two crura of which extend forwards along the inner and upper margins of the optic thalami. *h* and *i*. The corpora quadrigemina. *k*. Superior crus of cerebellum; close to *k* is the valve of Vieussens, which has been divided so as to expose the fourth ventricle. *l*. Hippocampus major and corpus fimbriatum, or tænia hippocampi. *m*. Hippocampus minor. *n*. Eminentia collateralis. *o*. Fourth ventricle. *p*. Posterior surface of medulla oblongata. *r*. Section of cerebellum. *s*. Upper part of left hemisphere of cerebellum exposed by the removal of part of the posterior cerebral lobe.

encephalon, even fatally (as in compression of the brain from fracture of the skull), provision must be made to avoid that pressure.

This is done, partly, by the adapted increase of rapidity in the escape of blood from the brain by the veins; but more effectually by the movements of the *cerebro-spinal fluid.* This is a serous liquid, contained beneath the arachnoid membrane of the brain and spinal marrow, and passing readily from one to the other. If more blood enters the brain, a larger amount of sub-arachnoid fluid leaves it to go into the spinal cavity; and *vice versâ.*

Upon the large and difficult subject of the functions of the cerebral hemispheres, much might be written (see *Carpenter's Human Physiology*). For economy of space it is proper to attempt here a statement only of the most positive, and some of the most probable conclusions as yet attainable in regard to it.

1. The *cerebral hemispheres* are the sole organs of *mind;* that is, of intellect and emotion, as well as of will. The *active* portions of the hemispheres are, on good ground, believed to be the superficial or peripheral *convolutions;* the white substance being commissural or communicative only.

2. The two hemispheres, under all ordinary conditions at least, act *as one.* Probably the *corpus callosum* is the main medium of their intimate correspondence.

3. The brain is, as regards the mental faculties, a *multiple* organ. This is proved by many facts; as, the *partial* mental activity of dreaming and somnambulism; partial insanity or monomania; the limited effects, upon the mental and moral powers, of some injuries; and those peculiar, special gifts of mind, so different in different individuals, to which we give the name of genius.

4. The system of "phrenology," or cranioscopy, taught by Gall, Spurzheim, and Combe, is not sustained by a sufficient preponderance of evidence to enable it to take its place as a part of physiological science.

Lately, the most remarkable suggestion tending in a similar direction to Gall's inquiries, is that of Broca and others, growing out of the facts concerning *aphasia.* This name is applied to loss of the power of expression in language, spoken or written, from cerebral disease. *Post-mortem* examination in a number of cases has exhibited some lesion of the anterior portion of the left hemisphere of the cerebrum. Broca and others have hence inferred that this part of the brain is the seat and organ of the "faculty of language." The principal objection to this view is, that it supposes an *unsymmetrical* location of function, in a part of the system, the cerebro-spinal axis, which, elsewhere, so far as is known, is entirely symmetrical.[1] Ferrier has recently (1873) given an account of some experiments upon animals, from which he infers a functional relation between certain portions of the convolutions of the cerebrum and particular muscles. So many facts stand against the probability of this inference, that it must be received at present with caution, if not distrust. One of his conclusions is, that the cerebellum is a motor centre for the muscles of the eyeballs. More probably, the only deduction as yet

[1] See the report in *American Journal of Medical Sciences*, July, 1868, p. 296, of a remarkable case of injury of the head, in which loss of language followed penetration of the *right* half of the brain.

warranted by his observations is, that the muscular movements produced depend on the connection between *emotion* (not ideation) and its *expression* by muscular actions. The author of this manual has taught in lectures for many years that it is most probable that the *intellectual* faculties are localized in the *posterior* lobes of the cerebrum, and the *emotions* in the *anterior* portions of the hemispheres. Two important facts sustain this view: 1. That the brain of man differs from that of the apes, carnivora, etc., most in the greater development of the posterior lobes. 2. That in the growth of the fœtus and maturation of the brain after birth, the posterior lobes are *last* formed and completed; as the intellectual faculties follow the instinctive and emotional (impulsive) powers and propensities in their order of relative development. Moreover, viewing the cerebellum as an organ apart, as it were, analogy favors the probable location of active (*emoto-motor*) or *motive* mental functions in the *anterior* portion of the cerebrum; as, in the spinal axis, all the anterior roots of the nerves are motor; and also the *corpora striata* are functionally connected with motion, while the thalami (posterior) are related to special and general sensation. There is, therefore, an *anterior* and a *posterior tract* in the cerebro-spinal axis; the former active, and the latter receptive, in function. Although we speak of intellectual *activity*, this is *subjective*, and altogether different from those impulses of emotion which always tend to result in action. Dr. Lombard, in some experiments upon the temperature of the brain, found that even a slight emotional excitement produced a rise in the heat of the head, such as did not attend mere thought or mental perception.

5. *Reflex action* affects the cerebrum, as it does all lower nerve-centres. Especially is excito-motor agency visible in *emotional* actions.

Dr. Carpenter's theory is, that *emotion* consists only in the attachment, in our consciousness, of either pleasure or pain to an *idea*. This is not, however, well sustained by familiar facts. Especially is it contradicted by the evident distinction that emotions, unlike ideas, are always *impulsive;* they form our *motives;* we are moved by them. Hence it is probable that different parts of the brain are the seats respectively of the intellectual faculties and of the emotions.

6. Not only is mental action often reflex, being induced by the *suggestion* of impressions external or internal—but it is also in many instances *automatic*. Will acts, not by direct compulsion of the faculties, but by the directing and selecting power of *attention*. We thus encourage and sustain preferred trains of thought; or, on the contrary, avert attention from those not approved. So, also, with emotions. Dwelling upon an object which naturally excites feeling, will still maintain this, even if the will struggles directly against the emotion itself.

Childhood exhibits the automatism of mental action most fully. Emotional impulses are stronger than mere instincts in youth; maturity brings the full development of the intellectual powers. Over all of these, the will ought to dominate; but some human

beings remain, all their lives, automata, under the continued dominion of impulses.

Remarkable exemplification, however, of the spontaneity or automatic character of the action of the mind, is witnessed in the manner of performance of great and peculiar genius. Often, highly gifted men are notably deficient in power of will; as shown by their impulsive nature and want of self-control. Carpenter adduces, as good instances of this, Mozart, the musical composer, and Coleridge, the poet and philosopher. Zerah Colburn in calculation, and Morphy in chess, are examples of different kinds of extraordinary natural superiority in particular gifts. Not always are such powers attended by uncommon general intelligence. Of the absence of this, Blind Tom, the negro pianist, a musical prodigy, but otherwise almost an idiot, is said to be an example.

7. There is reason, even, to believe, that mental action or "cerebration" may sometimes be *unconscious*. Dr. Carpenter's arguments in favor of this view are interesting and convincing; but would occupy too much space here.

SLEEP.

Only the cerebrum, the organ of the mental faculties, among all the nerve-centres of the body, has prolonged periods of complete repose in the order of nature. Short intervals, every centre, every organ in the body has; in the *alternations* or rhythmic actions which all exhibit. Thus, between each two inspirations, and between each two beats of the heart, short rests occur. But the brain must have several hours of continuous repose, every night, or day.

In the soundest sleep, total unconsciousness exists. Between this and sleep-walking, or somnambulism, all degrees may occur. The entire explanation of the physiology of sleep is not yet attained. The most interesting fact fully developed of late years is the observation of Durham and others, that during natural sleep less blood flows through the brain than at any other time; the cerebral hemispheres becoming, from diminished activity of their arterial circulation, comparatively anæmic.

In somnambulism, the sensori-motor powers appear to be, sometimes, as perfect as in the waking state; but acting automatically. Artificial somnambulism, which may be produced in some susceptible persons, has been exaggerated in description, into mesmerism or animal magnetism, etc.

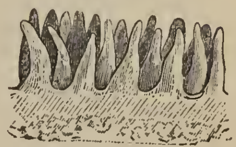
ORGANS OF SENSATION.

For the perception of an impression made upon any part of the body, three things are required: an organ or surface to receive the impression, a nerve to convey it, and a sensorial ganglion in the brain to perceive it. It is also requisite that *attention* be given to the sensation; as many impressions, especially if they be slight, may be made upon our organs, while the mind is strongly preoccupied, without our taking any cognizance of them.

Touch.

This is the simplest and most extensively diffused of all the senses; being sometimes, therefore, called *common sensation*. All the superficial parts of the body, and the inlets and outlets of the cavities, are endowed with it, in different degrees. The deeply-seated organs are not possessed of sensibility, although uneasiness and pain result from diseased conditions affecting them.

Fig. 193.



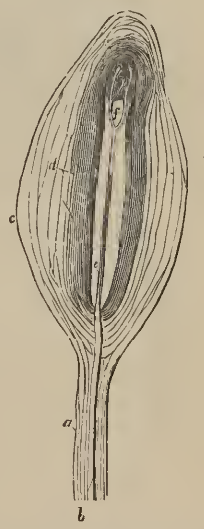
PAPILLÆ OF PALM.

Susceptibility to *pain* appears to be a different thing from the simple sense of touch. Anæsthetic inhalation (as of ether, nitrous oxide, or chloroform) may prevent, sometimes, the pain of an operation, while the patient feels every movement made.

Fig. 194.

PACINIAN CORPUSCLES.—Portion of digital nerve.

Fig. 195.



PACINIAN CORPUSCLE.—*a*. Peduncle. *b*. Nerve-fibre. *e*. Axis-cylinder. *f*. Subdivision of same. *c*, *d*. Laminated sheath.

The special organs of touch are the *papillæ tactus*. They are little irregularly conical projections, seen in rows, with wrinkles between them, especially upon the hands. Each papilla contains a (looped ?) termination of a nerve-filament, and a loop of capillary bloodvessels. On the digital nerves (of the fingers and toes),

the minute fibrous *Pacinian corpuscles* are found ; and also on the branches of the sympathetic going to the aorta, and on the nerves of the mesentery.

By pressing the points of a pair of compasses, tipped with cork, upon the skin, it may be shown that it is only when they are at a certain distance from each other that they are felt as two instead of one object. As the distance needed for their separate perception is different on different parts of the body, the comparative sensitiveness of each part may thus be measured. The following table exhibits the results of such experimentation (Weber, Valentin):—

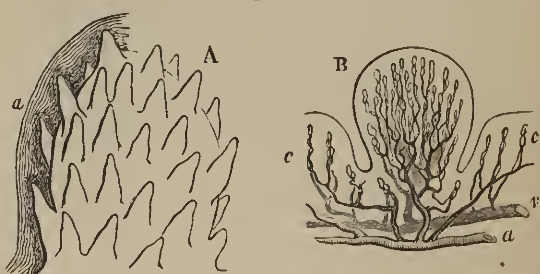
Point of tongue,	½ line	Lower forehead,	10 lines
Tip of forefinger,	1 "	Skin of occiput,	12 "
Red surface of lips,	2 lines	Back of hand,	14 "
Palm of hand,	5 "	Skin of back,	30 "
Skin of cheek,	5 "	Middle of arm,	30 "
End of great toe,	5 "	Outside of thigh,	30 "

The term *anæsthesia* is applied to any loss of sensibility, local or general, however produced. Not unfrequently it occurs as a form of *paralysis* or palsy.

Taste.

The tongue, and, to a less degree, the soft palate, are the seats of taste. The nerves conveying it are, for the tip of the tongue, the lingual branch of the 5th pair, and, for the middle of the tongue and palate, the lingual branch of the glosso-pharyngeal (8th).

Fig. 196.



FUNGIFORM PAPILLÆ OF TONGUE.—A. Papilla, with secondary papillæ. *a*. Epithelium. B. Papilla with capillaries injected.

Over the tongue are scattered numerous papillæ (see *Anatomy*), simple, filiform, fungiform, and circumvallate. Each of these, like the papillæ tactus, contains the end of a nerve and a loop of capillaries. For taste, it is necessary that particles of a sapid substance come in *contact* with the tongue in a state of *solution*. Unless the tongue is morbidly dry, the saliva will suffice to moisten sufficiently an otherwise dry material. A sensation of taste may be produced by a galvanic current ; as in the familiar experiment of placing a silver coin under the tongue, and a copper one upon it, so that they touch beyond the end of the tongue.

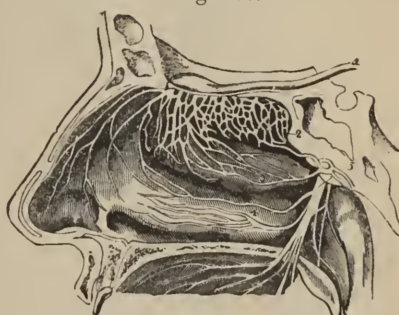
Impressions of taste are considerably heightened or modified by the simultaneous perception of odor in the same substance. Taste may be cultivated, as in wine-tasters and tea-tasters, to a high degree of delicacy.

The *use* of the sense of taste evidently is, not only to give pleasure in eating and drinking, but to guide in the selection of food. Among *natural* products, it is a generally sufficient guide. Of course artificial substances may, and frequently do, combine pleasantness of taste with poisonous qualities.

Smell.

The seat of this sense is the upper part of the lining membrane of the nasal cavities; receiving the distribution of the terminations of the olfactory nerve. The Schneiderian membrane of this region is a mucous tissue paved with *non-ciliated* cylindrical epithelium. Ciliated cells cover the lower or *respiratory* portion of the nasal cavities; but the nostrils themselves are lined with *squamous* epithelium. As in the case of taste, actual *contact* of odorous particles is necessary; but these particles may be extremely minute or subtle in diffusion. Thus a small piece of musk may give an odor to a very large apartment. A drop of creasote upon a table may leave a perceptible smell after repeated washings; and it seems sometimes almost impossible to wash the scent of the dissecting room from the hands. Most remarkable, however, is the power of certain animals to detect and pursue their prey by the scent, as the hound does the fox or hare, even while running at full speed. The delicacy of sensitiveness to impressions required for this is almost inconceivable.

Fig. 197.



THE NASAL CAVITY.—1. Olfactory nerve. 2 Superior turbinated bone. 3. Middle bone. 4. Inferior bone. 5. Fifth nerve.

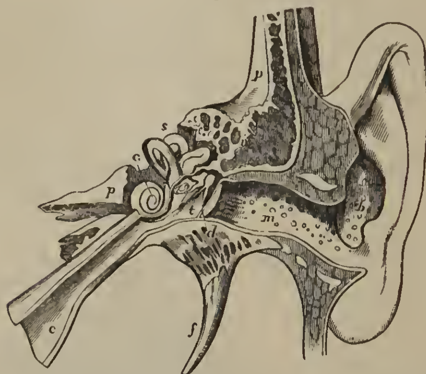
Among animals, to find their prey, or mates, is evidently a principal use of the organ of smell. We find it also capable of another service, in making known the presence of things which contaminate the air and make it insalubrious. All ordinary causes of atmospheric impurity, and consequently of ill health, are offensive to us.

Hearing.

Vibrations of sonorous bodies induce waves of air or of other media, which, impinging upon the ear, produce the impression upon the auditory nerve which we call sound. Rapid undulations produce high notes, slow ones grave or low notes; whether they come from a stringed or wind instrument, a bell that is struck, or

a human voice. In a receiver exhausted by the air-pump, the ringing of a bell will produce no sound; because there is no air to vibrate.

Fig. 198.



THE EAR.—*b*. Concha. *m*. External meatus. *d*. Membrana tympani. *t*. Cavity of tympanum. *e*. Eustachian tube. *i*. Mastoid cells. *s*. Semicircular canals. *c*. Cochlea. *p*. Petrous portion of temporal bone. *f*. Styloid process.

The essential part of the organ of hearing is the *internal ear*, where the terminations of the auditory nerve (portio mollis of seventh pair) are distributed. The *middle* and *external* ear, however, are important to the perfection of the organ as an instrument not only for the reception but also for the discrimination of sounds.

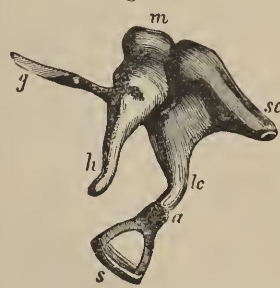
Referring the student to the Manual of Anatomy for the description of the structure of the ear, no more will be repeated here than is absolutely necessary to made our language intelligible.

External Ear.—Many animals have their ears movable in different directions, so as to receive sounds from various quarters more distinctly. Man, although possessing *rudimentary* (undeveloped) motor muscles of the ear, has not that power. Instead, the external ear is curiously curved and excavated; thus presenting a number of surfaces in different directions. The total result of these curves and channels is, the concentration or pouring of the aërial waves and reflections, as through a funnel, into the *external meatus*.

This passage ends in the *membrana tympani*. At its outer orifice are a number of hairs. Its lining tegument secretes, by follicles, the *cerumen* or wax of the ear. The purpose of this wax, whose odor is unpleasant, seems to be, to exclude insects and animalcules. The meatus is endowed with delicate sensibility. Probably we may be aided in determining the *direction* of sounds, by the mechanical impression of air-waves, when sound is most intense, upon its surface. The loss of the external ear lessens distinctness of hearing, but does not cause deafness.

Middle Ear, or Tympanum.—This is a cavity in the temporal bone, bounded on the outside by the *membrana tympani*, and within by the vestibule and part of the cochlea of the internal ear. It communicates with the upper part of the pharynx by the Eustachian tube. Within it, surrounded by air, is the chain of *ossicles*, the *malleus*, *incus*, *orbiculare*, and *stapes;* which connect the membrana tympani with the membrane of the foramen ovale (fenestra ovalis) of the vestibule. These little bones having a slight motion upon each other, three muscles affect their condition and the tension or relaxation of the tympanic membrane; the *tensor tympani*, *laxator tympani*, and *stapedius*.

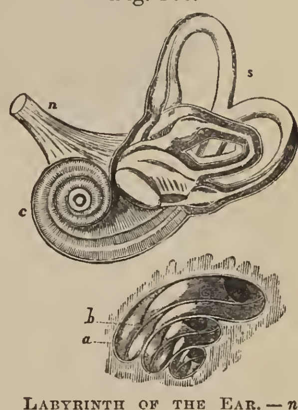
Fig. 199.



OSSICLES OF THE EAR.

The tympanum is, essentially, a drum. It is not air-tight, because, by the Eustachian tube, air is admitted into it. The use of this seems to be, that sonorous waves, impinging upon the membrana tympani from without, through the meatus, may be to a sufficient extent *balanced* within. Violent effects are thus provided against.

Fig. 200.



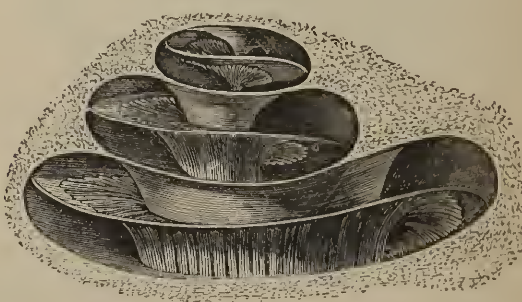
LABYRINTH OF THE EAR. — *n.* Auditory nerve. *s.* Semicircular canals. *c.* Cochlea. *a.* Osseous wall of the spiral tube of the cochlea. *b.* Spiral staircase.

Internal Ear, or Labyrinth. — Again referring to *Anatomy* for description, we may call attention only to the facts that the vestibule, cochlea, and semicircular canals contain fluid, and that within them are spread out the terminations of the auditory nerve. The vestibule communicates with the membrana tympani by the chain of ossicles. The cochlea has a foramen, the *foramen rotundum*, or *fenestra rotunda*, opening upon the cavity of the tympanum, but covered with membrane. Within the vestibule, are the *otoconia* or *otoliths*, minute calcareous crystals, whose whole use must be supposed to be, by their vibrations, to reinforce feeble impulses of sound and make them more appreciable.

The uses of the spiral shape and double "staircase" of the cochlea, and those of the three differently placed semicircular canals, are not yet known. The idea that the canals may serve to enable us to determine the *direction* of the origin of sounds (a not uncommon conjecture), is excluded by the fact that almost all sonorous vibrations enter by the *meatus externus*, and, after striking

upon the *membrana tympani*, have thereafter the same direction, whatever their origin. We can always judge best of the direction from which sounds proceed, when we can compare the difference in the intensity with which it affects the two ears. As, however, we can also determine the direction of a sound when one ear is closed, a further explanation is required. Very probably, the *external meatus* is endowed with sensibility to sonorous waves, adapted to this purpose. In some animals of quick hearing, as the bat and the mouse, an extremely fine plexus of nerves exists in the lining membrane of the external ear.

Fig. 201.



THE COCHLEA.

Probably the spiral "ascending and descending" staircase of the cochlea (communicating by a minute aperture at the *hamulus*) allows of the *roll* of every distinct wave of sound, intensifying it by the condensation and rarefaction produced by the narrowing and subsequent expansion of the double spiral ; no abrupt arrest or rebound of the wave being thus produced, but a gradual exhaustion of it. The *rods of Corti* are arranged in the *scala media* of the *lamina spiralis* of the cochlea, in a manner comparable to the keys of a piano. The perception of different tones or notes of sound may very possibly be connected with them. The rounded form and varied direction of the semicircular canals suggest that it may be their purpose, to give place for the escape and dying out of undulations which have made their impression upon the auditory nerve, and which, if they returned or reverberated in the vestibule and tympanum, would confuse the hearing. This has been compared with the arrest or "absorption," by the black pigment layer of the choroid coat of the eye, of rays of light which have made their impression upon the retina. It is commonly believed, however, that the semicircular canals serve especially to conduct to the auditory nerve sonorous undulations received by the solid bones of the head.

Transmission of Sound.—Sonorous vibrations move through the *air* at the rate of somewhat more than 1100 (1118–1142) feet in a second ; through *water*, 4900 feet in a second ; through solid bodies, much more rapidly, according to their density. When

such waves are transmitted by contact from one body to another, some loss of momentum and of rapidity in the undulations occurs; the note, if it be a continuous musical sound, is lowered. Savart proved that sounds may be audible which result from the succession of 24,000 impulses in a second; and, at the other extreme, of lowness, he found them audible when produced by seven or eight impulses, or fourteen or sixteen half-vibrations in a second.

If sound is conveyed by contact from air to water, a considerable loss is produced. But if a solid body, such as a metallic plate or an animal membrane, be placed upon the surface of the liquid intervening between it and the vibrating air, there is less diminution.

Precisely this arrangement exists in the ear. Sonorous waves are conveyed to the extremities of the auditory nerve by undulations (reciprocal and resonant) of *solids*, *liquid*, and *air*. First, as we ordinarily hear, the waves of air enter the meatus and strike upon the membrana tympani. Thence the undulations are carried inward, by, 1st, the *walls* of the tympanum; 2d, the chain of bones; 3d, the air within the tympanum. Thus they reach the *fenestra ovalis* by the foot of the stirrup-bone (stapes); the *fenestra rotunda* through the air; and the general surface of the labyrinth by the walls of the tympanum. Then the *liquid* (perilymph, endolymph) of the vestibule, cochlea, and canals receives the vibrations, and transmits them to the auditory nerve.

Defects of hearing may be produced by several causes. Slight degrees of deafness may attend the accumulation of wax in the ear; thickening, from catarrhal inflammation, of the membrani tympani; or obstruction of the Eustachian tube. More serious deafness follows perforation or destruction of the membrana tympani, or partial destruction of the chain of bones in the tympanum. *Total* loss of hearing only occurs when the auditory nerve, or its sensorial ganglionic centre, is paralyzed. A simple test will show whether deafness, in any case, be nerve-paralytic, or connected only with the mechanical apparatus of the ear. If it be the latter, the ticking of a watch may be heard when it is placed between the teeth; as the solid bones of the face and head, and the air entering the Eustachian tube, conduct the sound. This will not be the case, and no sound will be heard, if the auditory nerve has lost its receptive or transmitting power.

Vision.

An expanded surface sensitive to light, an optic nerve to convey impressions made by it, and a sensorial ganglion to receive and *perceive* them; these are the parts essential to sight. Beyond these, the eye is a visual *apparatus*, compared often to a *camera obscura*, or a photographer's instrument.

Light and vision are the subjects of an abstruse mathematical science, Optics. Some account of light is usually given in connection with chemical physics (see *Chemistry*). Brief allusion to a few facts concerning it is unavoidable here.

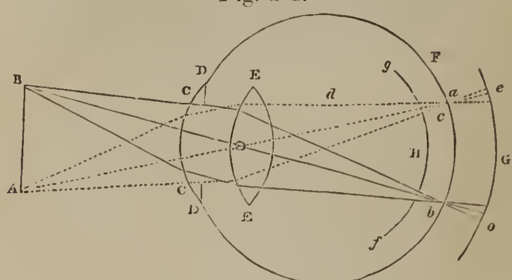
Adopting the *undulatory* theory, we conceive light to consist of extremely rapid vibrations, conveyed from luminous bodies to the eye through the *æther* which pervades space. This universal æthereal fluid penetrates even solid bodies, affecting and being

affected by the state and movement of their particles. Heat, electricity, galvanism, and magnetism, no doubt, involve its wave-movements, as well as those of ponderable substances. Light travels through space at the rate of from 186,000 to 192,000 miles[1] in a second.

Certain bodies *transmit* light; they are transparent. *Reflection* of light is a universal phenomenon or property of solids and liquids, although in very different degress. The *direction* of reflected rays is governed by their line of incidence, and the reflecting surface; according to the law of mathematical physics, that *the angle of incidence and the angle of reflection are equal.* The *colors* of bodies depend upon the colors of the rays of light which they reflect. A red body reflects only red rays; a green one, only green rays, etc. A black body, however, does not (theoretically) reflect any light at all. A white one reflects the whole of the light falling upon it.

Passing *through* transparent media, as water, glass, etc., rays of light are often made to change their course. This is called *refraction.* Thus a marble, at the bottom of a cup, not visible to an eye at a certain distance beyond its edge when the cup is empty, will seem to *rise up* and be seen over the edge when water is poured into it.

Fig. 202.



Emerging from water into air, a ray of light is bent in one direction; going from air into water, in another. Referring both, for comparison, to a line drawn perpendicularly to the surface entered or left, the law is thus expressed: a ray of light, in passing from a denser to a rarer medium, is refracted *from* the perpendicular; in passing from a rarer to a denser medium, *towards* the perpendicular.

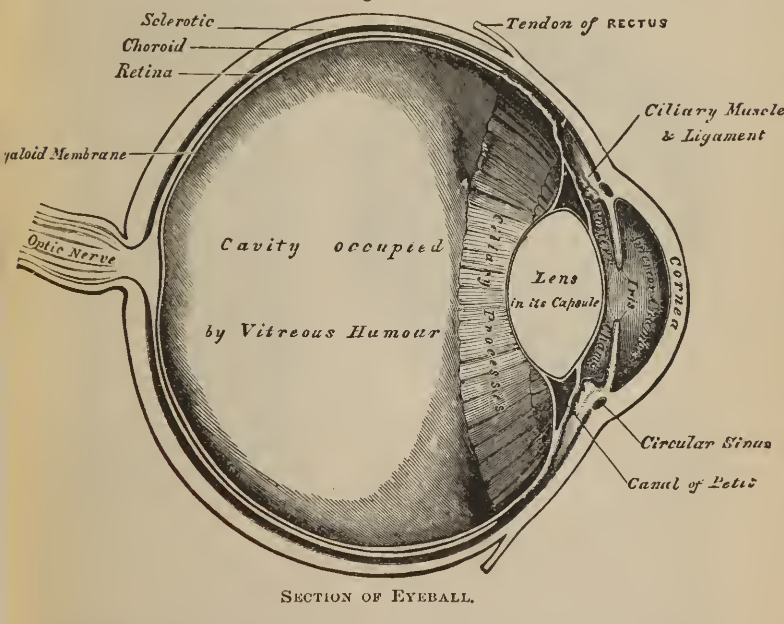
But refraction does not occur to the same extent or in just the same way with all substances, or with bodies of all forms. *Double refraction* and *polarization* of light are complex optical phenomena which cannot be entered upon here. By the action of a simple prism of glass, a ray of light in its transmission is *decomposed*, or separated into the seven rays of the *spectrum*, identical with those of the rainbow. Three *primary* rays are admitted, red, yellow, and

[1] According to different authorities.

blue; the others being combinations of these in different proportions. That white light is really made up of a union of all the colored rays, may be demonstrated by a physiological experiment. If a circular disk or flat piece of pasteboard be divided into seven equal parts, by lines radiating from the centre to the circumference, and the seven colors of the spectrum be painted upon these, when the disk is made to revolve rapidly it will appear to be white. This happens because the impression of any visible object upon the retina *remains* for a moment after looking at it. The quick succession of impressions, therefore, in the revolution of the disk, blends all the colors into one, and the result is whiteness.

Upon modifications in the reflection and refraction of light caused by different materials, forms, positions, and other conditions of bodies, depend the uses of the parts of the eye as an organ. For the full description of these parts we must refer to *Anatomy*.

Fig. 203.

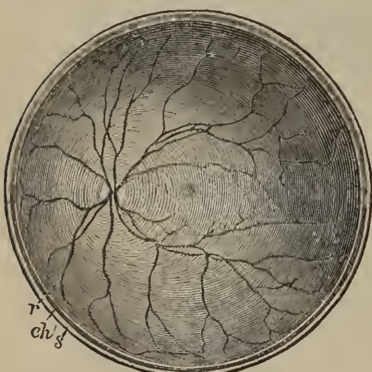


SECTION OF EYEBALL.

The transparent media of the eye are, the *cornea*, *aqueous humor*, *crystalline lens*, and *vitreous humor*. The receptive surface upon which, within the chamber of an eye, the picture or image is thrown (as upon the sensitive prepared plate of the photographer's apparatus) is the *retina*. Of this, the most important layers, physiologically, are, 1, the layer of rods and cones, which suggest analogy to the *papillæ* of touch; 2, the layer of ganglionic nerve-cells; 3, the radiating expansion of the termination of the optic nerve.

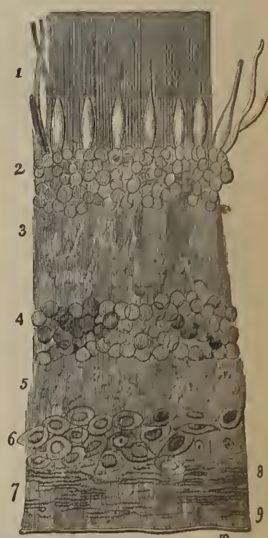
It is very remarkable that the point of entrance of this nerve into the retina, which is just within (*i. e.*, nearer to the nose than) the centre of its surface, is devoid of sensibility to light, as shown by careful experiments. At the centre of the retina, the *yellow spot* of Sœmmering is the point of most distinct vision. Evidently, the image of any object upon the retina must be *inverted;* because, the rays from its upper and lower extremities crossing each other as they enter the pupil, those rays from the top of the object must pass through to the bottom of the retina, and those from the bottom must go to the top of the same receptive surface. How, then, do we see everything right side up? Several theories have been proposed to explain this, which is certainly not a mere result of experience or education. Perhaps the crossing of the fibres of

Fig. 204.



The Posterior Half of the Retina of the Left Eye Viewed from Before. — *s.* The cut edge of the sclerotic coat. *ch.* The choroid. *r.* The retina; in the interior at the middle, the macula lutea with the depression of the fovea centralis is represented by a slight oval shade; towards the left side the light spot indicates the colliculus or eminence at the entrance of the optic nerve, from the centre of which the arteria centralis is seen spreading its branches into the retina, leaving the part occupied by the macula comparatively free.

Fig. 205.



Vertical Section of Retina of Human Eye.—1. Bacillar layer. 2. Outer layer, granular. 3. Intermediate fibrous layer. 4. Inner granular layer. 5. Finely granular gray layer. 6. Layer of nerve cells. 7. Layer of fibres of optic nerve. 8. Limitary membrane.

optic nerves, from the top and bottom of the retina, respectively, may *reverse*, in their conveyance of impressions to the tubercula quadrigemina, the picture itself. More reasonable, however, it is,

to suppose that the mind really sees, not the *retina with the image* upon it, as some imagine—but *from* the retina; that is, there receives and perceives waves of light from the reflecting visible *object*. So, as we refer a blow upon the hand or body to one or another source by our minds tracing backwards the direction of its impression upon us, we in like manner refer a ray of light to an object by tracing backwards its direction. When we look at a mirror, for example, and see an image of anything in it, the image *seems* to be *beyond* the glass; and it requires an effort of thought, or some experience, to correct this impression.

The crossing of the filaments of the two optic nerves in all possible directions, from side to side, has been, perhaps without sufficient evidence, supposed to explain the *unity* of human vision with two eyes, upon each of which a distinct impression is formed. If the eyes are placed out of correspondence, as in strabismus, double vision results. In habitual or permanent strabismus, the mind is apt to accustom itself to give attention only to one of the two images seen. Double vision is sometimes *subjective; i. e.*, connected as a symptom with disorder of the brain.

The cornea, aqueous humor, crystalline lens, and vitreous humor act upon light transmitted through them as a series of lenses. The anterior surface of the cornea is convex; the crystalline lens is doubly convex, the posterior surface being the most convex of the two. Applying to convex lenses the law of refraction already mentioned, that, in passing from a rarer to a denser medium, rays of light are bent or refracted *towards* the perpendicular, and remembering that at any part of the surface of a sphere a perpendicular to it is continuous with a straight line going to its centre, it will be obvious that parallel rays (or those nearly parallel) must, by such a lens, be made to *converge*, and, finally, to meet. The place at which the rays from any body thus unite is called the *focus* of the lens. Rays not parallel but divergent, as from a small and near body, cannot be brought so soon to a focus, unless the lens is modified so as to increase its refraction.

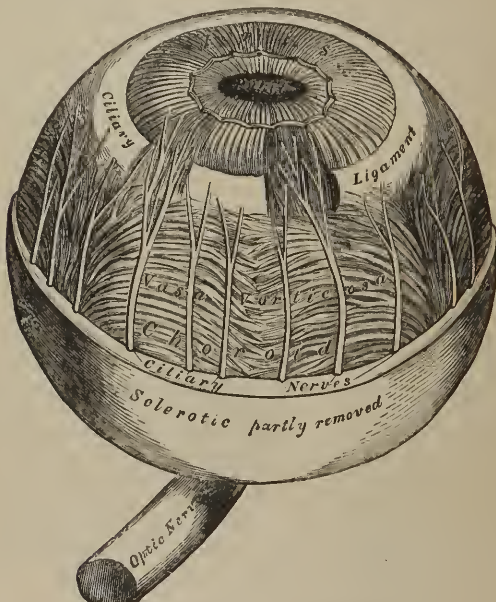
Adjustment of the eye to different distances, then, needs explanation. The theory now adopted is, that, as the eye *reposes* in distant vision, effort is required only for the sight of near objects; and that this is effected by removal or diminution of the pressure of the elastic suspensory ligament upon the lens, by the *ciliary muscle;* which is described by Wharton Jones, H. Müller, and Rouget as consisting, like the iris, of circular and radiating fibres. Perhaps the vascular processes of the *ciliary body* may, as an erectile structure, assist, when distended, in compressing the lens.

The *iris* contracts when we look at near objects, and thus excludes the most divergent rays. The general purpose of the iris is to regulate the amount of light entering the eye through the pupil. By reflex action, its circular fibres contract under the stimulus of light. When that stimulation is withdrawn, the radiating fibres dilate the pupil. The contraction of the pupil may be artificially produced by the action of the Calabar bean, or by opium in poisonous doses. Dilatation of the pupil follows the local or systemic action of stramonium, belladonna, hyoscyamus, or their active principles. The *afferent* or sensory nerves of the iris are the 2d

(optic) and 5th; the motor nerve in contraction of the pupil is the 3d; dilatation is under spinal and sympathetic influence.[1]

Optical instruments are liable especially to two defects; *chromatic* and *spherical aberration.* The first consists in change of color in objects seen through lenses, owing to the differently-colored rays being unequally refracted in their transmission. The

Fig. 206.



THE CHOROID AND IRIS (enlarged).

second is the deviation and confusion of rays impinging upon different parts of the surface of a convex lens. Those rays which pass from the centre of an object straight through the centre of the lens are not *refracted* at all. Those striking at a small distance from the centre are made to *converge* somewhat; those entering near the margin or circumference converge very much. So, they do not all meet in one focus, and an indistinct image results.

The correction of *chromatic* or color aberration is, by opticians, effected by using several lenses, of different materials, refracting

[1] The pupil contracts, under strong light, after death; according to Brown-Séquard, in eels and frogs, sixteen days after death. Exactly what is the functional relation between the 5th nerve and the iris is unsettled. After division of its ophthalmic branch, the pupil becomes immovable; in men and rabbits it remains contracted; in dogs and cats, dilated (Valentin).

the rays of light differently ; so that one corrects (by reversing it) the inequality produced by another. Thus, if the arrangement be perfect, white rays, or rays without change of color, are transmitted. In the construction of the eye, this principle is illustrated by a combination of several refracting media ; the cornea, aqueous humor, crystalline lens, and vitreous humor.

Spherical aberration is, in the eye, corrected in two ways. For one, the *iris* serves to exclude those rays which would strike the margin of the convexity of the lens ; and thus their tendency to confuse the image is prevented. Also, the *structure* of the crystalline *lens* admirably preserves the eye against this deviation of light. The lens is *most dense at the centre*, and lessens gradually in density towards the circumference. Thus those rays which strike it *near* the centre are made to converge more, in proportion, than those striking it towards the margin ; more, that is, than the form of the lens would cause them to do, if it were homogeneous ; but just the same as the others, by this correction ; so that a clear image is made.

Our ideas of the *distances* of objects are obtained through *experience*, with the comparison of other senses than sight, and the use of our powers of locomotion. To a person cured of congenital cataract, as in a case reported by Cheselden, or to one like Caspar Hauser, brought out into the light after years of imprisonment in darkness, everything seems at first *upon* or very near to the eye.

Size, also, is only very imperfectly determined by sight *alone*. The *visual angle* gives us some estimate of it ; that is, the angle made by the rays coming from the top and bottom, or the right and left side, of an object, and meeting upon the retina. Also, we are aided in measuring the size of an object seen, by the *muscular sense* of the muscles which move the eye up and down, or from side to side, in looking at it all over.

Our knowledge of the size of any object will facilitate our making an estimate of its distance ; and so, if we know its distance, we can judge better of its size. Hence, on a foggy day, many things look larger than they actually are, because haziness gives an impression of distance ; while, on the contrary, in an extremely clear atmosphere, things of unknown size may appear to be very near but small.

The *thaumatrope* is a simple toy, which well illustrates the fact that impressions made upon the eye remain for a little while. It consists of a piece of card, on each side of which is drawn or painted a different picture, the two bearing some relation to each other ; as, on one side a bird, on the other a cage ; or, on one side a man and on the other a horse. When the card is made to revolve rapidly so as to present the two sides alternately, the images are combined into one ; and the bird may be seen in the cage, or the man on the horse.

The *stereoscope* of Wheatstone is an instrument composed of two lenses, so placed as to cause two pictures of the same object, one representing the right side of it and the other the left (Fig. 207), to appear as one. The impression of *solidity* and perspective, which, in actually solid objects, we gain by the use of both eyes together, is thus perfectly conveyed by flat pictures ; as photographs, for example.

Imperfections of sight, in various degrees, are common and important. Their study and treatment belong to the special department of ophthalmic surgery. A few of them may be here briefly mentioned.

Near-sightedness, or *myopia*, is the most frequent of all. It is owing to too great a *convexity* of the crystalline lens, or else to an excess of *length* of the eyeball antero-posteriorly; the rays falling upon the eye from a distant object being brought to a focus *too soon*, that is, in front of the retina. The correction of this is obtained by the use of *concave* glasses, which by their refraction move back the image to the retina.

Fig. 207.

STEREOSCOPIC VISION.

Long-sightedness, or the incapacity to see objects at short distances, is due to causes the reverse of the above; the lens being *too flat*, or the eye too short from before backwards. The rays then converge too little to make an image upon the retina; their focus falling *behind* it. This (very common in old people) is corrected by *convex* glasses, which bring the rays to a focus sooner. Because of the frequency with which old persons experience this defect of vision, it is commonly called *presbyopia*. But age is apt to bring with it other kinds of failure of sight also; oftenest, a loss of power to *accommodate* the eye to the distance of objects, the *range* of vision becoming abnormally restricted.

Near point at	10th year	. . .	$2\frac{2}{3}$ inch from cornea.
" "	20th "	. . .	$3\frac{5}{9}$ " " "
" "	30th "	. . .	$4\frac{1}{5}$ " " "
" "	40th "	. . .	$6\frac{1}{7}$ " " "
" "	50th "	. . .	12 " " "
" "	60th "	. . .	24 " " "
" "	70th "	. . .	144 inches.

(Donders, Fellenberg, etc.)

Terms now much used by opticians are, *emmetropic*, *myopic*, (hypometropic) and *hypermetropic* vision ; also, *paralysis of accommodation*, and *astigmatism*. *Emmetropic* is *normal* sight, with the full natural range of accommodation. Many persons can see to read, for example, with ease, letters at a distance of seven inches from the eyes, or at thirty-six inches, or at any distance between. That is their range of accommodation. *Myopic* persons sometimes can only read with the book two or three inches from the eye. *Hypermetropia* is deficiency in the refracting power of the eye, so that only convergent rays make distinct images, and thus only objects at some distance can be well seen. It is what is most generally called presbyopia. *Astigmatism* is indistinctness of vision from differences in refraction by the eye according to the part of it upon which rays fall ; a want of harmony in refraction. This is tested by looking at the two lines of a cross, or a large letter T ; the lines in different directions not being seen with equal clearness. It may be remedied by employing cylindrical lenses (see *Laurence and Moon's Ophthalmic Surgery*).

Amblyopia is indistinctness of vision. *Asthenopia* is *feebleness* of visual power, shown by the eyes becoming soon exhausted when used, as in reading, and images then becoming confused. This is a symptom of *fatigue* of the ciliary muscle, retina, optic nerve, or tubercula quadrigemina ; calling for *repose* of the eyes.

Amaurosis (a term repudiated now by some ophthalmologists) is nerve-blindness, or paralysis of the optic nerve.

Cataract is opacity either of the crystalline lens or of its capsule. Though sometimes congenital, it occurs in much the largest number of instances in advanced life. Occasionally it is observed in connection with *diabetes mellitus;* and, experimentally, it has been produced in animals, by injecting sugar into the tissues. The theory of endosmosis has been brought forward to aid in explaining some of these facts.

Accessory Apparatus of the Eye.—The *lachrymal gland* is very important, on account of the protection its constantly flowing moisture affords in clearing fine particles from the surface of the eyeball, and keeping it from shrinking with dryness. The *Meibomian* glands of the eyelids furnish a sebaceous material which maintains the flexibility of the eyelashes. The *lashes* themselves (cilia) are especially protective in their use, acting somewhat like cow-catchers in front of a locomotive, their convexities being turned towards each other. *Winking* is a (generally automatic and often unconscious) motion of the lids, by which the lachrymal secretion is brought frequently over the ball, and, when needful, the eye is closed against the entrance of foreign bodies. The *eyebrows* (supercilia) are protective overhanging ridges, covered with hairs, which aid in keeping blows or falls from affecting the eyes, and also avert from them drops of perspiration of the forehead. For an account of all these auxiliary structures see *Anatomy*.

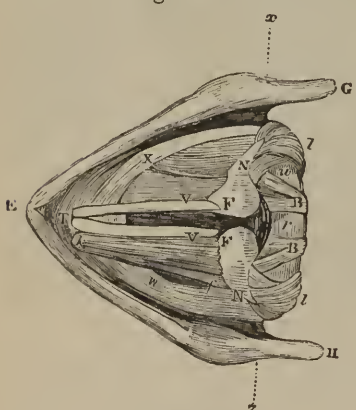
CHAPTER VIII.

THE VOICE.

THE larynx is the organ of voice in man. Referring to Anatomy for the particular description of its parts, we may consider what is its nature as an instrument.

Among musical instruments, two kinds are most decidedly different; *wind* and *stringed* instruments. Of the former, the trumpet, horn, trombone, flute, and fife are examples. Of the latter, the violin, guitar, etc. In wind instruments, the notes vary with the length (and width) of the *column of air*, affected by the closing and opening of the holes, and the manner of impelling air from the mouth. In stringed instruments, the *length*, *thickness*, *and degree of tension* of the strings principally determine the notes. In both, the larger vibrating mass, moving in slower waves, gives low notes; the shorter column or cord produces quicker vibrations, and higher notes.

Fig. 208.



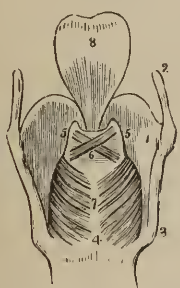
GLOTTIS, FROM ABOVE.—G, E, H. Thyroid cartilage. N, F. Arytenoids. T, V. Vocal ligaments. N, *x*, *v*, *k*, *f*, N, *l*. Muscles. B. Crico-arytenoid ligaments.

But there is an intermediate kind of instrument; that with a *tongue* or *reed*, that is, a vibrating plate or membrane, in connection with a tube. The clarionet, bassoon, hautboy, and reed stops of an organ are of this kind. The human larynx is a reed instrument, neither precisely a wind nor a stringed one. The reeds are the *vocal ligaments;* the *epiglottis* is also of that nature.

Except in the production of very high notes, only the *inferior* vocal cords are shown, by experiment and by observations with the laryngoscope, to be essential to voice. The *anterior* part of the glottis, also, is the vocal part. The changes which occur in vocalization are, the *widening* and *narrowing* of the *glottis*, and the increase and diminution of the *tension* of the *ligaments*. These changes are effected by muscles. The *posterior crico-arytenoid*

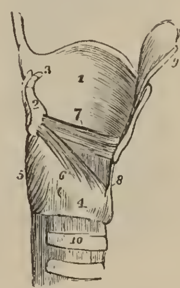
muscles draw back the arytenoid cartilages, and make tense the ligaments; the *crico-thyroid* muscles aid in the same effect. The *posterior arytenoid* muscles, *transverse* and *oblique*, narrow the orifice of the glottis. Both of these movements cause elevation of the pitch of sounds. The *thyro-arytenoid* muscles relax the ligaments by drawing the arytenoid cartilages forward. The *lateral crico-arytenoid* muscles widen the aperture of the glottis. Thus grave or low notes are produced. The lowest human tone has 80 vibrations per second; the highest, 1024 vibrations.

Fig. 209.



Posterior View of the Larynx.—1. Thyroid cartilage, right ala. 2. Ascending cornu. 3. Descending cornu. 4. Cricoid cartilage. 5, 5. Arytænoid cartilages. 6. Arytænoideus muscle, consisting of oblique and transverse fasciculi. 7. Crico-arytænoidei postici muscles. 8. Epiglottis.

Fig. 210.



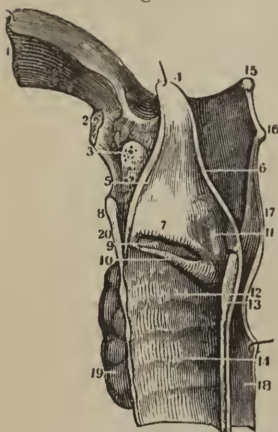
Side View of the Larynx, one ala of the thyroid cartilage (the right), having been removed.—1. Left ala of thyroid cartilage. 2. Right arytænoid cartilage. 3. Corniculum laryngis (or cartilage of Santorini). 4. Cricoid cartilage. 5. Crico-arytænoideus posticus muscle. 6. Crico-arytænoideus lateralis. 7. Thyro-arytænoideus. 8. Crico-thyroid membrane. 9. One-half of the epiglottis. 10. Upper part of the trachea.

The compass of the voice extends in singers to two or three octaves. The lowest note of the female voice is about an octave higher than the lowest of the male voice, and the highest of the female voice an octave above the highest of the male. This depends chiefly on the greater length of the ligaments in the male larynx. The larynx in boys is like that of the adult female. At puberty it changes, with other sexual developments.

"There are two kinds of male voice, the bass and tenor, and two kinds of female voice, the contr'alto and soprano. The bass voice usually reaches lower than the tenor, and its strength lies in the low notes; while the tenor extends higher than the bass. The contr'alto has generally lower notes than the soprano, and is strongest in the lower notes of the female voice, while the soprano voice reaches higher in the scale. But the difference of compass, and of power in different parts of the scale, are not the essential

distinctions between them. The important difference consists in their tone or 'timbre,' which distinguishes them even when they are singing the same note. The qualities of the barytone and mezzo-soprano voices are less marked, the barytone being intermediate between the bass and tenor; the mezzo-soprano between the contr'alto and soprano." (*Kirkes.*)

Fig. 211.



THE LARYNX OPENED. 7. Superior vocal ligament. 8. Thyroid cartilage. 9. Ventricle of Galen. 10. Inferior vocal ligament. 11. Arytenoid cartilages. 12. Cricoid cartilage.

In each octave there are twelve semitones. Within each semitone at least six different notes can be produced; 120 notes or more can, then, be made distinctly by an ordinary singer. Yet the vocal ligaments vary in length but $\frac{1}{5}$ of an inch. Each note requires, therefore, a variation in the state of the ligaments of but $\frac{1}{600}$ of an inch. In falsetto notes, it would appear that only the edges of the vocal cords approach each other.

The lungs are the *wind-box* of the vocal organ; the manner in which air is impelled through the larynx making much difference in vocalization. The solid and flexible structures of the mouth and nostrils also affect and modify it considerably.

For speech, *articulation* as well as voice is necessary. In this, the tongue, palate, lips, and teeth are employed. Besides the *vowel* sounds, some of which may be continuously pronounced—as ah, au, e, eh, ih, uh, oo, while others are compound, as a, i, o, oi, ow, yu, the *consonants* are, by some writers, divided into *linguals*, *dentals*, *labials*, etc. These distinctions are not very accurate. The tongue is used in c, hard and soft, d, g, hard and soft, h, j, k, l, n, q, r, s, t, x, y, z. The lips especially in b, p, f, m, v, w. The teeth are expressly touched by the tongue in s, z, and th. Reverberation in the nasal cavities occurs in the *prolonged* sounds of b, d, g, l, m, n, r, v, w, y, z, and also in certain compound sounds, as ng.

The following table is from Kempelen :—

Vowel.	Sound.	Size of oral opening.	Size of oral canal.
a as in	"far,"	5	3
a "	"name,"	4	2
e "	"theme,"	3	1
o "	"go,"	2	4
oo "	"cool,"	1	5

In other languages than the English, many sounds exist which no combination of our letters is capable of expressing.

Stammering is owing to a want of control of the will over the muscles of articulation. It is to be treated and cured, therefore, by systematic and well-devised *vocal gymnastics;* instruments afford only very slight palliation for it.

CHAPTER IX.

DEVELOPMENT.

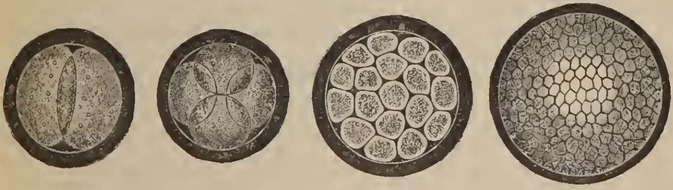
CONCEPTION.

ACTUAL contact of the spermatozoa and ovule is necessary for impregnation ; more than this, according to recent observers, not only contact but penetration of the ovule by the spermatozoa. Barry, Nelson, Keber, and others have seen spermatozoa inside the ovule in various animals. In most, if not all cases, there appears to be a penetration by many of them. Spermatozoa, at the same time, pass through the coats of the vitellus, and, massing around the germ cell, lose their motor power, become disintegrated and disappear, after having awakened the germ to its wonderful life.

THE EMBRYO.

The first change in the ovule (henceforth known as the ovum) is cleavage or segmentation of the yelk. The embryo cell elongates, becomes somewhat fiddle-shaped, divides into two cells by the ordinary process of cell-division. At the same time the yelk divides into two parts, so that each cell is contained in its own separate yelk mass. By repetition of this process we have 4—8—16 cells and yelk masses formed, and so on until segmentation is completed, and out of the germ cell and yelk is formed a homogeneous mass of cells—the *germ mass.* During this, there has been an evident increase of cells at the expense of the yelk.

Fig. 212.



DIAGRAMS OF THE VARIOUS STAGES OF CLEAVAGE OF THE YELK.

After the formation of the germ mass the cells nearest the surface, immediately under the zona pellucida or vitellary membrane, become aggregated to form a membrane, the so-called blastoder-

mic or *germinal membrane*, which soon divides itself into the external or *serous layer* and the internal or *mucous layer*, between which the other germinal cells are collected, forming the *vascular layer*. The first of these gives origin to the vertebral column, skull, extremities, nerves, general skeleton, brain, and spinal cord. In the second, the glands and mucous structures are formed, whilst the vascular system, including the heart, originates in the intervening layer—the vascular. Soon there is an evident thickening at one end of this fourfold ball, as it were; a heaping together of cells, and the dense area thus formed receives the name of *area germinativa*, which is first roundish, then oval, then pyriform. In the centre of this, which is of course made up of three layers, the cells of the serous and mucous layers become comparatively few in number, and a semitransparent spot is thus caused, the so-called *area pellucida*, which is bounded laterally by an accumulation of the cells of the vascular layer, the *area vasculosa*. In the serous lamina, in the centre of the *area pellucida*, appears soon the *primitive trace*, a transparent groove, the first sign of the fœtus. It is surrounded above by two ridges, the *laminæ dorsales*, which, during development, arch over the groove and finally unite above, inclosing the groove in which the cerebro-spinal nerve centres are afterwards formed, whilst the laminæ are transformed into the spinal column and skull.

In the same way two ridges grow out below the primitive trace, arch over (or rather under), and unite, thus forming the abdominal cavity of the fœtus. These are the *laminæ ventrales*. It is readily seen that if either the dorsal or ventral laminæ fail to unite, there will result a monstrous fœtus; if it be the former which do not join, the spinal column will be incomplete, and *spina bifida* will occur; if the latter, the anterior part of the body will be incomplete, and *hare-lip*, *cleft palate*, or other malformation dependent on insufficient development of the walls of the chest or abdomen will be present. In the area vasculosa, which is inclosed in the laminæ ventrales, the bloodvessels are formed by the union of rows of cells, and obliteration of their separating walls; their nuclei (according to Dr. Carpenter) forming the blood disks. In like manner the heart is formed after the vessels; the first flow of blood is towards the heart, the so-called *punctum saliens* (Fig. 215).

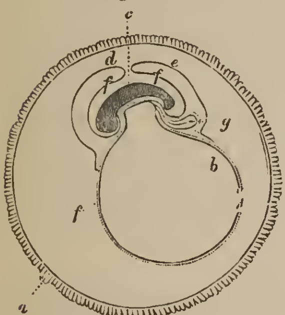
Amnion.

The *amnion*, the essential envelope of the ovum, appears very early in the formation of the embryo. A little beyond the extremities of the ovum, on the outside of the area pellucida, the serous lamina projects in two hollow processes, which arch over the dorsum of the embryo and unite to inclose it. At first these two processes are widely separated in their central portion; but soon they spread also over the ventral surface of the embryo, and ultimately surround the elements of the umbilical cord: of the two layers, which thus form the amnion, the outer becomes adherent to the external or maternal membrane, the other constitutes the especial envelope of the fœtus.

The membrane thus formed embraces the embryo very closely at an early period, and is continuous with the common integument

of the fœtus, at the open abdominal parietes. At a later period it is distended with fluid, and so separated from the fœtus, and after being reflected upon the funis, of which it forms the outer coat, it terminates at the umbilicus. It is thin and transparent, but of a firm texture, resisting laceration much more than the other membranes. Its external surface is somewhat flocculent, but internally it is quite smooth, like serous membrane, and like it secretes a bland fluid. This fluid resembles dilute serum, and is

Fig. 213.



THE AMNION AND CHORION.—*a.* Chorion. *b.* Umbilical vesicle, surrounded by the serous and vascular laminæ. *c.* Embryo. *d, e,* and *f.* External and internal folds of the serous layer, forming the amnion. *g.* Incipient allantois.

Fig. 214.

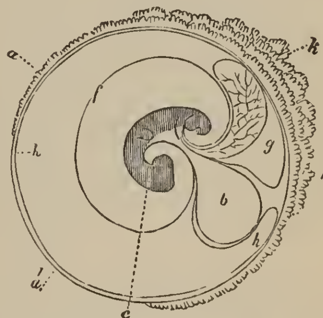


DIAGRAM REPRESENTING A HUMAN OVUM IN SECOND MONTH.—*a* 1. Smooth portion of chorion. *a* 2. Villous portion of chorion. *k. k.* Elongated villi, beginning to collect into placenta. *b.* Yelk sac, or umbilical vesicle. *c.* Embryo. *f* Amnion (inner layer). *g.* Allantois. *h.* Outer layer of amnion, coalescing with chorion.

called *liquor amnii.* It varies in amount from half a pint to several quarts, the average quantity being about half a pound. It subserves several useful ends. It probably serves as nutriment to the fœtus during the early months; it preserves an equable temperature for it while remaining in utero; it protects it from the effects of sudden blows, shocks, etc. It is also useful in dilating the os uteri, by protruding the membranes in the commencement of labor.

It will be remembered that the mucous layer is the most internal, being that which immediately surrounds and contains the yelk. The first change in it is the appearance of a constriction caused by the growing from it, towards the centre of the yelk, of a pair of processes, which increase in size until they finally meet and divide the cavity of the mucous layer into two; in the smaller of these, the one next to the embryo, the mucous membranes, glands, etc., are developed, whilst the larger consists largely of the yelk and is the so-called *umbilical vesicle.* Connecting these cavities is a small canal, the *vitelline duct.* The embryo, at this period, chiefly subsists on the yelk contained in the umbilical vesicle; which

reaches it not merely through the duct but by means of vessels, the *vasa omphalo-mesenterica*, developed on the walls of the part of the mucous layer composing the duct. These vessels terminate in the superior mesenteric artery and vein. When, finally, the store of yelk is exhausted, the umbilical vesicle shrinks up and leaves a sort of scar, the white spot, *vesicula alba.*

Allantois.

The *allantois* is formed at the lower and anterior part of the embryo, rather from a mass of cells than by a reduplication of one of the primary layers. It is at first a delicate membranous elongated sack, but, like the cavity of the mucous layer, it is divided into two by constriction. The smaller of these divisions becomes the urinary bladder, the other, the allantois proper. The *urachus* of the perfected animal (the cord leading from the bladder to the umbilicus) is the remains of the duct connecting the fœtal bladder with the allantois. The allantois extends itself until at last it comes in contact with the uterine surface. It becomes vascular, and in birds surrounds the whole embryo, and lines the inner surface of the shell. Its further history in the human subject will be traced directly.

The Decidua.

While this development has been going on, certain changes have taken place in the uterus, which it is now necessary to notice.

Fig. 215.

Diagram of the Fœtus and Membranes about the Sixth Week.—*a.* Chorion. *b.* The larger absorbent extremities, the site of the placenta. *c.* Allantois. *d.* Amnion. *e.* Urachus. *e.* Bladder. *f.* Vesicula umbilicalis. *g.* Communicating canal between the vesicula umbilicalis and intestine. *h.* Vena umbilicalis. *i, i.* Arteria umbilicalis. *k.* Arteria omphalo-mesenterica. *l.* Vena omphalo-mesenterica. *n.* Heart. *o.* Rudiment of superior extremity. *p.* Rudiment of lower extremity.

The earliest change in this organ after impregnation consists in an enlargement of the tubular glands of the mucous membrane, and of the capillaries between them; the glands becoming visible to the naked eye, and pouring out profusely a peculiar secretion of albuminous matter and cells. These together, *i. e.*, the entire altered mucous membrane of the uterus, constitute the *decidua vera* which lines the cavity of the uterus. According to Coste, the ovum on entering the uterus is imbedded in the soft altered mucous membrane, and as it were sinks into it, the latter throwing out granulations which arch over the ovum and form a membrane covering it, *decidua reflexa.* Other authorities have believed that this membrane arises as follows: by the time the ovum reaches the uterine orifice of the Fallopian tube, the uterine mucous membrane has become so swollen as completely to occlude it, so that the ovum necessarily in entering the uterus pushes before it a part of the mucous membrane which constitutes the membrana reflexa. It will be seen that there is therefore a double membrane; one part of which lines the uterus, the decidua vera; the other enwraps the fœtus, the decidua reflexa; the whole of which constitutes the *membrana decidua*, so called, because cast off at the birth of the child.

Chorion.

The *chorion* is another envelope of the fœtus obtained from the mother and partially formed before the ovum arrives at the uterus. When the ovum leaves the ovary it is enveloped in a portion of the proliferous disk, which adheres to it and constitutes the first appearance of the chorion. In the passage through the Fallopian tubes, new gelatinous material is secreted; until, by the time the ovum arrives at the uterus, it is inclosed in a thick membrane, which, at its first appearance, was smooth, but now is rough and shaggy from the enlargement of numerous villi.

Fig. 216.

Villi of Chorion.

This new formation is one of great importance, as it is through it that the whole subsequent nutrition of the embryo is derived; this is accomplished at first by means of the villous processes which proceed from the whole surface of the chorion and give it a rough, shaggy appearance. These villous processes serve as absorbing radicles, drawing in the fluids supplied by the mother, until a more perfect communication is afforded by the placenta. As the ovum advances in age, these villi diminish in number, assume a vesicular appearance, and finally disappear altogether; *except* at that part of the chorion which is in contact with the uterus, and where the *placenta* is subsequently formed. In

some animals, this original connection between the villous coat of the chorion and the uterine surface is the only one that exists; hence they are called *non-placental.*

Placenta.

It will be remembered that we left the allantois passing out of the umbilicus towards the maternal organs. By the time it reaches the decidua reflexa, this, as well as the decidua vera, has become much thickened at the spot which it touches, and the villi of the chorion have there become remarkably enlarged. The placenta is thus formed, by the fusion of the choroin and decidua; the former being connected by the allantois with the ovum. The villi of the placenta are the villi of the chorion capped by the decidua. The human placenta, at full term, is of a soft spongy texture, round or slightly oval, from six to eight inches in diameter and from one to two inches thick; its fœtal or inner surface covered by the amnion is smooth, and generally has the umbilical cord inserted near its centre; sometimes to one side, when it is known as the *battledore* placenta. The external or maternal face of the cast-off placenta is seen to be divided somewhat irregularly into lobes, and covered by the hypertrophic mucous membrane of the uterus, into which the tufts of the chorion have penetrated. The placenta is destitute of nerves and lymphatics, and is in its structure essentially vascular. It will be seen that there are two parts to it; the fœtal and maternal.

The *fœtal* portion of the placenta consists of the branches of the umbilical vessels, which divide minutely where they enter the organ, and constitute by their ramifications a large portion of its substance; each subdivision terminating in a villus. Each villus contains a capillary vessel, which forms a series of loops, communicating with an artery on one side and with a vein on the other. The vessels of the villi are covered by a layer of cells inclosed in basement membrane. The *maternal* portion may be considered as a large sac, consisting of a prolongation of the internal coat of the great uterine vessels. Against the fœtal surface of this sac the placental tufts push themselves, dipping down into it and carrying before them a portion of its thin wall, so as to constitute a sheath to each tuft. The blood is conveyed into the cavity of the placenta by the "curling arteries," so named from their tortuous course, which proceed from the arteries of the uterus, and the blood is returned through large uterine veins called *sinuses.* It must not, however, be understood that there is any direct communication between the vessels of the fœtus and those of the mother, the fœtal tufts being merely *bathed* in the maternal blood and drawing nourishment from it by cells, which have the power of selecting, and of elaborating their own materials. The placenta performs the threefold office of an absorbing, respiratory, and excreting organ. It begins to be formed about the end of the second month; acquires its peculiar character during the third, and goes on increasing in proportion to the development of the ovum.

Umbilical Cord.

The *umbilical cord* is formed from a portion of the allantois; it connects the fœtus to the placenta and affords a passage to the blood from one to the other. It contains two umbilical arteries, and one umbilical vein, the duct of the umbilical vesicle, the omphalo-mesenteric vessels, the urachus, and sometimes more or less of the intestinal canal, the whole imbedded in the *Whartonian jelly*, and invested by a reflection from the amnion. Its length varies much; the average, however, is about eighteen inches. Sometimes it is so short as seriously to impede the progress of labor.

FŒTAL GROWTH.

The head is one of the first portions to be developed. At the beginning of the second month, it constitutes almost half of the entire mass of the fœtus. The upper extremities appear in the early part of the fifth week, as two blunt processes; and, immediately afterwards, the lower limbs. In both cases, the distal parts, *i. e.*, the hands and feet, are the first to be formed, so that they appear, as it were, sessile upon or fixed directly to the trunk; then the parts next to these, *i. e.*, the forearms and legs, and, finally, the arms and thighs. The motions of the child are rarely perceptible before the third month, and the beating of the heart is generally first heard during the fifth month. The average length of a full-grown child at birth, is about eighteen inches; the weight varies from four to eighteen pounds; the average probably being seven or eight pounds—a male weighing about one pound more than a female.

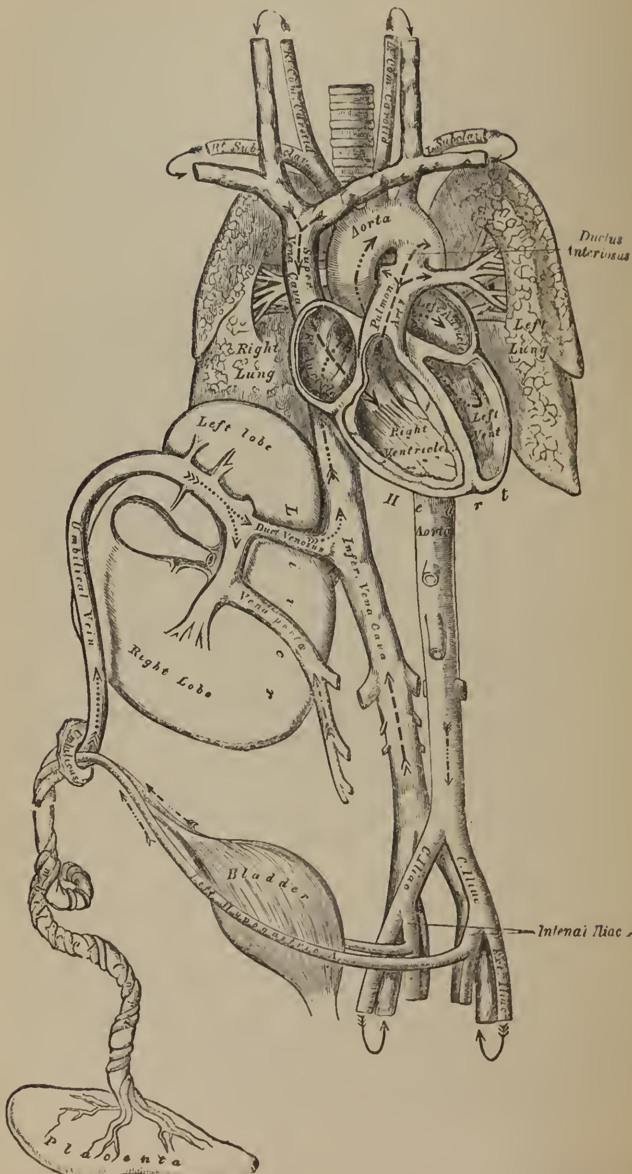
Development of the Spine and Cranium.—The primitive part of the vertebral column in all vertebrates is the gelatinous chorda dorsalis, which tapers to a point at the two extremities of the animal. In its development, it becomes inclosed in a membranous sheath, which acquires a fibrous structure. The chorda dorsalis is to be regarded as the axis of the future bodies of the vertebræ, although it never itself passes into the cartilaginous or osseous state.

The cranium is a prolongation of the vertebral column. At first, it consists of but one mass, a cerebral capsule, the chorda dorsalis being continued into its base. The bones of the face are developed later.

Circulation of the Fœtus.—There are some peculiarities in this. The chief are owing to the presence of the foramen ovale and ductus arteriosus in the thorax, umbilical artery and vein and the ductus venosus in the abdomen.

The *foramen ovale* is an opening between the two auricles of the heart, allowing the blood to pass freely from one to the other. The *ductus arteriosus* arises from the pulmonary artery near its origin, and conducts the blood from the right auricle to the aorta, into which it empties just below the arch. The *ductus venosus* passes from the umbilical vein to the vena cava ascendens along the thick edge of the liver.

Fig. 217.


Rt. Com. Carotid
L. Com. Carotid
Rt. Subclavian
L. Subclav.
Aorta
Super. Vena Cava
Ductus Arteriosus
Palmon. Art.
Left Auricle
Right Lung
Left Lung
Right Ventricle
Left Vent
Left lobe
Right Lobe
Duct Venosus
Infer. Vena Cava
Vena porta
Umbilical Vein
H e r t
Aorta
C. Iliac
C. Iliac
Internal Iliac At.
Bladder
Placenta

The following is the course of the blood: It is conveyed from the placenta along the umbilical vein, partly, at once, to the vena cava ascendens by means of the ductus venosus, partly into the liver, whence it reaches the vena cava by the hepatic vein. Having passed through the two great fœtal depurating organs (liver and placenta) it is in the state of arterial blood. It enters the right auricle; but, being directed through the foramen ovale by the Eustachian valve, arrives at the left auricle, thence goes to the left ventricle, and is thrown out into the aorta. Pure arterial blood is, therefore, sent to the head and upper extremities. At the contraction of the ventricles, the right one throws its venous blood into the pulmonary artery; but a small part of it passes to the lungs, the greater portion going through the ductus arteriosus into the descending aorta, where it mingles with the descending arterial current. Thus the blood supplied to the trunk and lower extremities is mixed arterial and venous. Of the descending current just spoken of, a small part goes to supply the trunk and lower extremities with nutriment, but the chief portion passes directly to the placenta through the umbilical arteries; whence it is returned

Fig. 218.

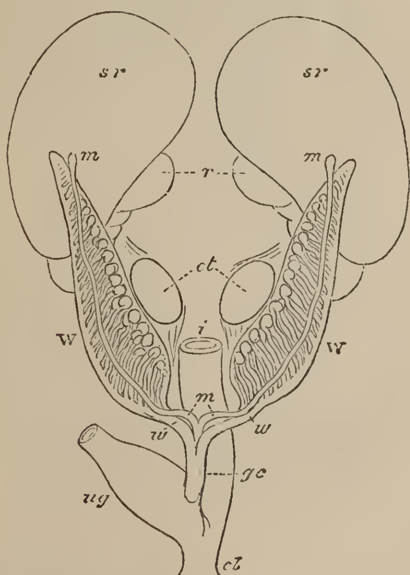


Diagram of the Wolffian Bodies, Mullerian Ducts, and Adjacent Parts, Previous to Sexual Distinction, as seen from before.—*sr.* The suprarenal bodies. *r.* The kidneys. *ot.* Common blastema of ovaries or testicles. W. Wolffian bodies. *w.* Wolffian ducts. *m, m,* Müllerian ducts. *gc.* Genital cord. *ug.* Sinus urogenitalis. *i.* Intestine. *cl.* Cloaca.

by means of the umbilical vein, after having been aerated and nourished by endosmotic action between it and the maternal blood.

The Wolffian Bodies, and Sexual Organs.—The Wolffian bodies are *temporary* rather than *rudimental* kidneys; for although they discharge the functions of these latter organs, they are not developed into them.

In man, the Wolffian bodies are bean-shaped, and are composed of transverse cæcal canals, united by an excretory duct which leads from the lower extremity of the organ to the sinus urogenitalis of the fœtus. The kidneys and suprarenal capsules are developed behind them. Their size is at first so great that they entirely conceal the kidneys; but they grow relatively smaller. Towards the end of fœtal life, only an atrophied remnant of them is left. Their ducts, in the male, are developed to form the vas deferens and ejaculatory duct of each side; the vesiculæ seminales forming diverticula from their lower part. In the female the ducts of the Wolffian bodies disappear.

The testicles or ovaries are formed at the internal border of these organs; and at first it is not possible to say which of them—the testicle or ovary—the new formation is to become. Gradually, however, the special characters belonging to them are developed.

Descent of the Testes.—In the seventh month of gestation, the testicle descends, in the line of the *gubernaculum testis*, through the *internal abdominal ring*, *inguinal canal*, and *external ring;* entering the scrotum during the eight month. In the female the *round ligament of the uterus* is homologous (*i. e.*, corresponds) with the gubernaculum testis of the male subject.

CHANGES AT BIRTH.

After birth and the expansion of the lungs, this course of the blood is entirely changed. The ductus venosus and ductus arteriosus become impermeable, and, finally, consolidated into fibrous cords; the foramen ovale closes, by the apposition and union of its valves; the pulmonary artery and vein enlarge in accordance with the increase of their function, and the regular round of the human circulation commences. If for any reason these changes do not take place, serious organic disease is the result. Thus, when the foramen ovale remains patulous, there is in consequence a constant mixture of arterial and venous blood, resulting in the production of the well-known phenomenon of the so-called *cyanosis* or "*blue disease.*"[1]

INFANCY AND ADOLESCENCE.

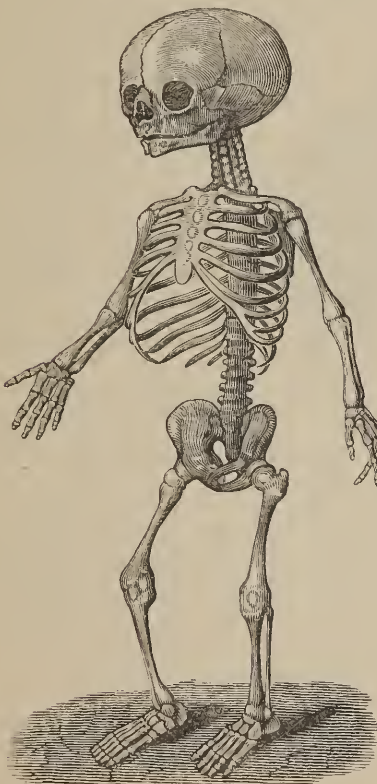
A new-born child has a very large head, upper extremities and abdomen, in proportion to its pelvis and lower limbs. The umbilicus is nearly at the middle of its body. Gradually all the parts approach to the perfect symmetry of adolescence and maturity.

Breathing by the lungs is less active, and that by the skin more so, in infancy than later in life. The power of generating animal

[1] Produced also by insufficient enlargement of the pulmonary artery.

heat is less, and the need of protection or communicated heat much greater at that time than afterwards. The skin and alimentary canal are extremely delicate and impressible. Kölliker states that all the hairs of the head and body are renewed in the first year.

Fig. 219.



FŒTAL SKELETON.

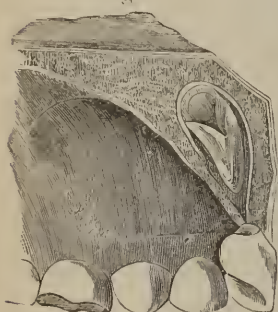
Of the nervous system, the organic or ganglionic (sympathetic) and the spinal reflex apparatus are most nearly mature at birth. Excito-motor involuntary actions are predominant over those of purpose and will, throughout childhood. Convulsions are more readily produced by irritating causes in infants and children than in adults.

At birth, the twenty first teeth are partly formed in both jaws,

but beneath the gums. The following is the usual order of their protrusion or "cutting." Two central incisors, in each jaw, in the seventh month; two lateral incisors, eighth month; two anterior molars (first jaw teeth), end of twelfth month; two canines ("stomach teeth" of lower jaw, "eye-teeth" of upper), eighteenth month; two second molars or jaw teeth, twentieth to twenty-fourth month. Those of the lower jaw are generally first.

At about seven years of age, the second teeth begin to replace the others. The first to appear, commonly, is the first permanent molar tooth, at six years and a half. Next, at seven years, the permanent middle incisors. At eight, the lateral incisors follow. The first and second bicuspids before ten years of age. The four canines, upper and lower, before twelve. At thirteen, the second permanent molars. The third and last molars ("wisdom teeth") between seventeen and twenty-one; making in all thirty-two teeth of the second set; in each jaw, four incisors, two canines, four bicuspids, and six molars.

Fig. 220.



DEVELOPMENT OF TEETH.

The age of *puberty*, from fourteen to sixteen in temperate climates, is marked by important changes. Sex is now manifested, by menstruation and the development of the breasts in the female, and by the change of voice and growth of beard in the male. Emotional differences also appear.

The muscular system and the bony skeleton develop progressively from infancy to maturity. This is seldom reached before the twenty-fifth year. The osseous union of the ends and shafts (epiphyses and diaphyses) of the long bones, and that of the different bones of the head, may sometimes be incomplete even to a later period; and, according to some anatomists, the brain may grow until forty, and the heart still longer.

The following table, from Dalton, exhibits the comparative proportion of different organs to the whole body, at birth and maturity:—

	Fœtus at term.	Adult.
Weight of entire body	1000.00	1000.00
" Thymus gland	3.00	0.00
" Thyroid "	0.60	0.51
" Renal capsules	1.63	0.13
" Kidneys	6.00	4.00
" Heart	7.77	4.17
" Liver	37.00	29.00
" Brain	148.00	23.00

Old age is shown by general *atrophy* or failure of nutrition as well as of power; frequently attended by various forms of degeneration of structure and defective functional action, tending towards death.

A MANUAL

OF

CHEMISTRY.

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PART III.—ORGANIC CHEMISTRY.

CHEMISTRY.

PRELIMINARY OBSERVATIONS.

THE Science of CHEMISTRY embraces the whole range of nature —animate and inanimate, organic and inorganic. As an *art*, it aids materially in the great purposes of civilization, such as manufactures, mining, agriculture, pharmacy, etc.

As chemical action has to do only with the molecules or atoms of bodies, Chemistry may be defined to be "the science which investigates the molecular changes of bodies."

The whole material world is subject to *Force*. Matter is incapable of spontaneous change; this property of matter is denominated *inertia*. Every change is the result of Force.

The *nature* of Force is unknown; it is manifested only by its *effects*. Two great opposite effects of force appear to exist—Attraction and Repulsion. Bodies are either solid, liquid, or gaseous, according as one or the other of these preponderates; thus, if the particles of a body adhere so closely together by virtue of an attractive force (cohesion) as to require an exterior power to separate them, the body is termed a *solid;* if the cohesion is so slight as to allow the particles to move upon each other, the body is called a *liquid;* and if the particles are kept apart by a repulsive force, entirely overcoming the cohesion, the body is denominated a *vapor* or *gas*.

ATTRACTION comprises several more or less distinct subdivisions, as Cohesion, Gravitation, Capillarity, Osmose, and Chemical Attraction, or Affinity.

Cohesion.—This is the attraction between homogeneous molecules, as, for instance, in a piece of iron, wood, or stone. It is only exerted at insensible distances, the molecules never being in *absolute* contact; the spaces between them are called *physical pores;* these, of course, are exceedingly minute, but are believed to be greater in proportion than the particles themselves. The property of *elasticity* depends upon this fact, since it could not exist unless there was space for the molecules of the elastic body to move in.

Gravitation.—This attractive force is displayed between masses, and at sensible distances, as between the sun and planets; it gives *weight* to bodies, and is the cause of the tendency of bodies to fall towards the earth's centre. The law of gravitation is that "the attraction is directly as the quantity of matter, and inversely as the square of the distance."

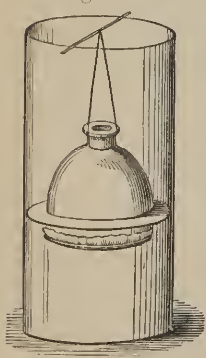
Capillarity.—The attraction exerted between solids and liquids.

It has received its name from the fact of its being especially exhibited between liquids and fine tubes, named *capillary*, in which the liquid rises to some distance above the surrounding level; the height depending on the smallness of the calibre of the tube—being inversely to the latter. This is the cause of bodies being wetted when placed in contact with certain liquids, the latter being attracted to the surfaces of the former. Capillarity is not exerted equally between all solids and liquids; on the contrary, in some cases there is a positive repulsion, as between glass and mercury. The mere density of the liquid does not, however, modify this force. Capillarity is believed to play an important part in the *capillary circulation* both of plants and animals.

Osmose.—This is exerted between two liquids of different densities, through an intervening membrane. The liquids must be capable of mixing together, and must have some affinity for the membrane. Under these conditions, there will be a mutual commingling through the pores of the membrane; but the rapidity of the two currents will be unequal, and will be modified by the membrane. The general law is that "the stronger current is from the rarer to the denser liquid." The term *endosmose* is generally used to express the stronger current, no matter which direction it may take. This force is apparently a modification of capillarity, though it is influenced by the relation subsisting between the membrane and the surface of the liquid.

Dialysis is a modification of Osmose. It signifies a *separation*, and is the method employed to effect a separation of two or more substances when in a state of solution. Graham divides bodies in solution into two classes—*crystalloids*, or such as tend to crystallize, and *colloids*, or such as do not, but tend, on evaporation, to form a glue-like mass. On putting a solution of a crystalloid and colloid into a vessel furnished with a bottom of *parchment-paper*, and placing the whole in another vessel containing pure water, the crystalloid will pass through into the water, while the colloid will be retained. This has been satisfactorily applied to the separation of small quantities of poisons, such as arsenic, tartar emetic, and even strychnia, from organic matters: the poison passes into the water, while the organic impurities remain behind. Urine may, in this manner, be made to yield its urea and salts to water. Generally, the whole of the crystalloid does not pass through the membrane.

Fig. 221.



Diffusion of gases is analogous to this. If two gases of different densities be allowed to communicate through a fine tube, or a porous septum, they will soon thoroughly commingle; the heavier rising, and the lighter falling, contrary to gravity. The rate or rapidity of their passage varies materially, however: thus, if oxygen and hydrogen be the two gases employed, the rate will be as one to four; that is, one cubic inch of oxygen will pass through in

one direction, while four cubic inches of hydrogen pass in the other direction. According to Professor Graham, the diffusibility of gases is "inversely as the square roots of their densities;" thus, in the instance above given, the densities of oxygen and hydrogen are as sixteen to one; hence the diffusive power of the former is four times less than that of the latter. This law is of great importance in nature, preventing the accumulation of noxious gases in any one spot, and also regulating the intimate mixture of the constituents of the atmosphere.

In the process of Respiration, the interchange between the inspired oxygen and the carbonic acid of the lungs is effected through *moist* membranes, which considerably modify their respective diffusibility, on account of their different solubility in water.

Chemical Attraction, or Affinity.—This is the attraction between heterogeneous particles. Like cohesion, it is exerted only at insensible distances, that is, apparent contact between the particles must take place; but unlike cohesion, or indeed, any of the other varieties of Attraction, *combination produced by it is always accompanied by a change of properties.*

Repulsion is directly antagonistic to attraction. Exerted between the molecules or particles of matter, it produces expansion, and change of condition into the liquid and aeriform states. This force is especially witnessed in gases, imparting to them an almost unlimited degree of expansion. The most frequent cause of repulsion is heat. Electricity and magnetism also produce it under certain circumstances.

PART I.

PHYSICS.

CHAPTER I.

GENERAL CONSIDERATIONS.

Physical Condition of the Atmosphere.

As the atmosphere surrounds us equally on all sides, we are insensible of its weight or pressure under ordinary circumstances; but the proof of its weight is afforded in various ways: 1. By accurately weighing a large glass balloon before and after the contained air has been exhausted; the difference in the weight is very perceptible. 2. By placing the hand over the mouth of the receiver of the air-pump, and exhausting the air from the interior; a painful pressure will be experienced from the superincumbent

atmosphere. 3. If a bladder be tied over the mouth of a receiver, and the air withdrawn, the pressure will be sufficient to burst the bladder with a loud report: a similar result follows if a thin glass receiver be exposed to the exhausting operation of the air-pump. All the above experiments prove conclusively that the air has weight. The *amount* of this weight is beautifully demonstrated by the *Torricellian experiment*, which consists in filling a glass tube, forty to fifty inches long, closed at one end, with mercury, and plunging the open end, when inverted and closed with the finger, into a vessel of the same liquid: the mercury will descend to about the level of thirty inches. It is kept at this height by the pressure of the atmosphere on the mercury in the basin, as is proved by breaking off the top of the tube, when the mercury immediately falls to the bottom. Now, it is ascertained that a column of mercury thirty inches high and one inch square, weighs nearly fifteen pounds; hence the inference that the atmosphere presses upon every square inch of the earth's surface with a weight equal to fifteen pounds. If water had been used in the above experiment, in the place of mercury, the column would have risen to the height of about thirty-four feet; a fluid of still lesser density would be sustained at a proportionably greater height. One hundred cubic inches of air weigh 30.829 grains (mean).

The barometer is but a modification of Torricelli's tube. It consists of a glass tube about thirty-four inches long, closed at one extremity, and filled with mercury, and then inverted so as to place the open end in a small cup of mercury. The pressure of the atmosphere upon the surface of the latter sustains the mercury in the column, as before mentioned. According to the variation of pressure the mercurial column will rise or fall. On this account the barometer is of great use in ascertaining altitudes, since the greater the elevation the lower the depression of the mercurial column, on account of the diminished pressure of the atmosphere. It has been ascertained that the fall of one inch indicates an altitude of about nine hundred and twenty-two feet. This ratio is true, however, only near the level of the sea, for, as the height increases arithmetically, the pressure diminishes geometrically. At the level of the sea, as already mentioned, the barometer ordinarily stands at thirty inches; at three miles elevation, it stands fifteen inches; at six miles, it falls to 7.50 inches; at nine miles, to 3.75 inches, etc. The height of the atmosphere is believed to be forty-five miles or more. The use of the barometer as a weather-glass depends upon the fact that the atmospheric pressure varies at the same place; when it stands highest, fair weather is indicated, and *vice versâ*. A sudden fall of the barometer usually portends a storm.

As already remarked, gases are far more elastic than either solids or liquids. The elasticity of the air, and of gases in general, depends upon the degree of pressure to which they are subjected. By the law of Mariotte, their *density and elastic force are directly as the pressure, and inversely as the volume.* Thus, one hundred cubic inches of air under a certain pressure, will expand to two hundred cubic inches, if the pressure is reduced one-half; or contract to fifty cubic inches, if the pressure is doubled.

The action of the siphon, of the common water-pump and the

air-pump, depends solely on atmospheric pressure; the elevation of the piston in the two latter cases producing a vacuum, which is instantly filled by the pressure of the air forcing in the fluid. The action of the *cupping-glass* is due to the same principle.

Specific Gravity.

The *weight* of a body expresses the degree of attraction between it and the earth; it signifies the ratio of the mass of a body (or its quantity of matter) to its volume or bulk; thus a body weighing ten pounds is believed to have ten times as much matter as a body weighing one pound.

Specific Gravity.—By this we understand the relative weights of equal bulks of different bodies; thus a cubic inch of water weighs seven times less than a cubic inch of iron; hence we say that their specific gravities are as 1 to 7. In order to compare the weights of equal volumes of different substances, water at the temperature of 60° F. is assumed as the arbitrary standard for all solids and liquids; and air at 60° with the barometer at 30 in., as the unit for gases.

To find the Specific Gravity of a Liquid.—It is only requisite to weigh equal bulks of that liquid and water, at the same temperature, and then divide the former weight by the latter; the quotient will, of course, be greater or less than unity, as the liquid employed is heavier or lighter than water. Now the simplest mode of weighing equal bulks is to weigh them in succession in the same vessel, taking care to have exactly the same quantity in both cases.

The common *specific-gravity bottle* is a light flask made to hold exactly 1000 grains of pure water. The specific gravity of any other liquid is readily ascertained by filling the bottle with the liquid and weighing it. Thus, filled with mercury it would weigh 13,500 grains; with alcohol it would weigh 792 grains; the specific gravity of mercury, therefore, is 13.5, and that of alcohol, .792.

Another method of ascertaining the specific gravity of liquids is by the use of the *hydrometer*, an instrument consisting of a hollow metallic ball attached to a thin stem which is graduated, and having a weight beneath to keep it erect. The use of the hydrometer is very simple. The liquid to be tried is put into a narrow vessel and the instrument floated in it. It is obvious that the denser the liquid the higher will the hydrometer float, and *vice versâ*. The point on the graduated stem in contact with the level of the liquid will express the specific gravity. Various modifications of this instrument are used, under the names of *urinometer*, *lactometer*, and *saccharometer*.

Fig. 222.

HYDROMETER.

A third method is by *displacement*. Weigh a solid body—as the stopple of a bottle, first in water and then in the given liquid; divide the latter weight by the former, and the quotient will be the specific gravity sought.

To find the Specific Gravity of a Solid.—The principle here is precisely the same as in the case of liquids; the rule being "to divide the weight of a given bulk of the body, by the weight of an equal bulk of water." The principle depends upon the well-known hydrostatic law that a solid body immersed in a liquid displaces exactly its own bulk of the liquid. All we have to do, then, is to weigh the body first in air, then in water; ascertain how much weight it thus loses; this *loss* is precisely equal to the weight of an equal bulk of water; then divide the first weight by the last, and the quotient will be the specific gravity: thus, a mass of iron weighing fifty-six grains in the air, loses eight grains on being immersed in water, therefore $56 \div 8 = 7$, which is the specific gravity of iron.

When the solid is lighter than water, as a piece of cork, it is weighed and attached to a body (the weight of which in air and water is known) sufficient to sink it. This compound mass is then weighed in air, and its loss of weight in water determined. The loss of the heavy body being known, that of the light body is easily determined by subtraction, and the specific gravity is determined as before. Thus a piece of wood weighed in the air 200 grains; attached to a piece of copper, the mass weighed 2247 grains in the air, and 1620 grains in water, losing 627 grains. The copper alone lost in water 230 grains; therefore $627 - 230 = 397$ grains = the loss of the wood alone; hence $200 \div 397 = .504$, the specific gravity of the wood.

When the solid is soluble in water, its specific gravity is taken with reference to some other liquid in which it is not soluble. The quantity thus obtained, multiplied by the specific gravity of the liquid, gives the specific gravity of the solid.

To find the specific gravity of gases the same principle is employed. Fill a glass globe, of known capacity, with the gas, then weigh it accurately, and divide the weight of the gas by the weight of the same volume of *air*, which is the standard or unity for gases. It is to be remembered that the specific gravity of gases and vapors is influenced by their *purity*, their *hygrometric condition*, the degree of *pressure* to which they are subjected, and their *temperature*.

CHAPTER II.

HEAT.

THE term *heat* is employed in two different senses, the one signifying the sensation produced by a heated body, the other the cause of heat; this latter is sometimes called *caloric*. Two theories have prevailed; the first, that it is a subtle, material, imponderable body, which enters between the pores or atoms of substances, thereby causing the phenomena of expansion, fusion, and the aeriform state. The second theory assumes caloric to be a "mode of motion" among the particles of bodies, producing rapid vi-

brations among them, which (in some not well understood way) cause all the phenomena of heat; the most rapid movement of the particles throwing them entirely beyond the power of cohesion and so converting a solid into a liquid and a vapor. This theory is now almost universally adopted.

Heat is usually spoken of under the two heads of *sensible*, or that which is evident to the thermometer, and *latent*, or that which is insensible. *Latent heat* may be illustrated by the following experiment: Mix together a pound of water at 176° and a pound of water at 32°; the temperature of the mixture will be 104°, the mean of the two; but if a pound of *ice* at 32° be used instead of water, the resulting temperature will be only 32°, *but the ice will have melted.* Hence in the last experiment all the additional heat of the water (144°) has been absorbed by the ice, without, however, making it any warmer, but simply *changing its state* (melting it). Heat so absorbed is termed *latent.* Again, on heating a vessel of water, the thermometer will indicate a constant increase of temperature up to the boiling point, 212° F.; beyond this point, however, provided the steam escapes, no further increase of heat will be indicated, because all the additional heat is rendered latent—being employed in producing a change of state in the water, *i. e.*, converting it into vapor. That the heat is really *latent* in the steam, may be easily proved by passing the steam into cold water, when it at once becomes *sensible* again by rapidly raising the temperature of the water; a quantity ten times the weight of the steam being raised nearly one hundred degrees in temperature. Hence the latent heat of steam is nearly 1000 degrees.

The above law is universal. Whenever a solid body becomes liquid, or a liquid assumes the gaseous state, a quantity of heat disappears, or is rendered latent; and conversely, when a gas or liquid is converted into a liquid or solid, all the latent heat is disengaged, and becomes sensible. The amount of latent heat of different bodies varies considerably.

On this principle, the cold produced by the use of freezing mixtures is explained; thus, a mixture of snow, or powdered ice and common salt, lowers the temperature to zero F., in consequence of the attraction between the two substances producing liquefaction, and thereby rendering latent a large amount of heat. A notable depression is also caused by the simple solution of certain salts in water, as of nitre, sal-ammoniac, etc. A striking example of the reverse process, or of rendering latent heat sensible by condensation, is afforded in the slaking of lime by water; here, the large amount of heat evolved arises from the water passing into the solid state, in its combination with the lime. Latent heat has hence been denominated the *heat of fluidity*, since it is necessary to maintain bodies in the fluid condition.

Effects of Heat.—Expansion

Expansion is one of the first and most obvious effects of heat. As it is opposed to cohesion, it follows that those bodies that are least influenced by cohesion, are most expansible by heat; hence liquids more than solids, and gases more than liquids.

Expansion in solids—May be proved by accurate measurement before and after heating, as by the experiment of the metallic ball and ring; by the familiar instance of hooping a wheel; and by the elongation of the metallic bar in the *pyrometer*, under the influence of heat.

Of solids, the *metals* are the most expansible, though not all equally so: lead is the most expansible; platinum the least. This difference is well illustrated by the compound metallic bar (composed of brass and iron riveted together); when heated, it is curved in one direction; and when cooled, in the opposite direction. Beyond certain limits, solids do not expand equally for equal increments of heat.

Expansion in liquids.—Liquids are more expansible than solids by heat, on account of their less cohesiveness. If a mercurial and an alcoholic thermometer be placed in a vessel of hot water, the alcohol will rise much higher in the tube than the mercury. Liquids are not equally expansible; nor is there any relation between their expansibility and their other properties, as density, etc. In heating from 32° to 212°, alcohol expands one-ninth of its whole bulk; water, one-twenty-third; mercury, one-fifty-fifth. The rate of expansion of liquids is not uniform; it increases with equal increments of heat because the cohesive force is constantly lessening.

There is a remarkable exception to the law that liquids expand by heat, in the case of water near the freezing point; it *expands* on being cooled below 39° F.; hence, ice swims on water. The expansion of water in the act of freezing is attended with very considerable force. *Salt* water, as that of the sea, does not expand before congealing.

Expansion in gases.—Gases are much more expansible than either liquids or solids. Their *rate* of expansion is very nearly uniform for equal amounts of heat—being about $\frac{1}{462}$ of their bulk at 32°, for one degree of Fahrenheit. It does not vary materially in different gases.

Thermometers are instruments for estimating sensible heat, by means of the expansion and contraction of a fluid. They do not indicate the *quantity*, but only the *intensity* of heat in a body. The first one invented was that of *Sanctorio* (Fig. 223). It consists of a glass tube terminating in a bulb, partially filled with air, and the open end plunged into some colored liquid; the expansion and contraction of the contained air is marked by the fall and rise of the liquid in the tube. This thermometer is liable to two objections; the expansibility of air is too great to mark very considerable changes of temperature; and it is liable also to be influenced by atmospheric pressure.

Leslie's differential thermometer (Fig. 224) is a modification of Sanctorio's; it consists of a glass tube bent at right angles, and terminating in two bulbs. Both bulbs contain air, but the greater part of the tube is filled with a colored liquid. The slightest difference in the temperature of the two bulbs is immediately indicated by the movement of the liquid in the tubes, under the pressure of the inclosed air.

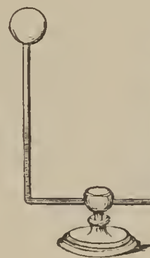
Liquids are much better adapted than gases for thermometers.

Of liquids, mercury is the best suited, on account of the large range between its boiling point, 662°, and its freezing point, —40° ; its expansion also between 32° and 212° is very nearly uniform.

Fig. 223.

Sanctorio's Thermometer.

Fig. 224.



Differential Thermometer.

The *essentials* in a thermometer are : a capillary tube of uniform bore, terminating in a bulb, the proper filling it with pure mercury, and the mode of notation. The two fixed points—the boiling and freezing of water—are then ascertained, and noted in the scale, and the intermediate space is marked off according to the scale that is adopted. In Fahrenheit's scale the boiling point of water is 212°, and the freezing point, 32° ; the intermediate space is divided into 180 degrees. In the centigrade (Celsius') thermometer, the boiling point is 100°, and the freezing point, zero. In Reaumur's, the boiling point is placed at 80°, and the freezing point at zero. As the ratio of these three scales is to each other as 180, 100, and 80, or 9, 5, and 4, it is easy to reduce one to the other.

The spirit (alcoholic) thermometer is used when very low temperatures are to be noted ; alcohol having never been frozen.

The expansibility of the air by heat is the cause of the phenomena of *winds*. The sun's rays falling nearly vertically at the equator, and obliquely at the poles, produce very unequal temperatures at these points. The air at the equator becoming rarified by heat, the dense cold air from the poles rushes towards the equator and displaces it, producing an upward current. In this way, two currents are established towards the equator, one from the north, and another from the south pole, besides the upward current. In consequence, however, of the earth's rotation upon its axis from west to east, the two currents just alluded to will take an oblique direction from east to west. These winds are called the *trade-winds*. There must also be *return* currents, in the opposite directions, to maintain the equilibrium of the atmosphere.

Communication or Transfer of Heat.

Heat may be communicated to bodies in different modes ; by *contact*, as in the *conduction* of solids, and the *circulation* of liquids ; by *radiation*, and by *reflection*.

Conduction of heat, or its transfer from one particle to another, varies much in different bodies. Of solids, the *metals* are the best conductors, although among these there is considerable variation. Gold is the best conductor, and lead the worst. Glass, porcelain, and marble are much inferior to metals. *Davy's safety lamp* for miners illustrates the conducting power of metallic surfaces. Its principle is, simply, the inclosure of a small lamp within a covering of *wire gauze*. When exposed in the mines to inflammable gas, the flame of the wick is often extinguished, and the gas *within* the gauze takes fire; but the metal cools this flame by contact with it, so that it does not set fire to the gas outside.

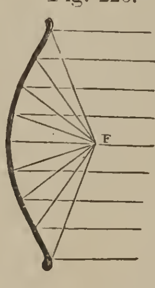
Liquids and gases are nearly destitute of conducting power, as may be easily shown by applying heat to the top of them, the heat being slowly propagated to the subjacent particles. They are really heated by *convection* or *circulation*, that is, by applying the heat at the bottom, when instantly there are two currents set in motion, the hot particles rising towards the surface, and the colder ones descending.

Radiation of heat.—Heat is emitted from a hot body in straight lines or rays, in all directions, just as rays of light are emitted from a luminous body. Such heat is termed *radiant* heat. These calorific rays pass freely through the air, or a vacuum, without sensibly affecting its temperature. When they fall upon the surface of a solid or liquid body, they are disposed of in four different ways: 1, they may be *reflected;* 2, they may be *absorbed;* 3, they may pass through it or be *transmitted;* 4, they may be *polarized*. In the first and third cases, the temperature of the body is unaffected; in the second case it is elevated.

The radiating power of bodies varies very much: it depends chiefly upon the nature of their *surfaces*—those which are rough and soiled throwing out much more heat than those that are smooth and polished. Lampblack is the best radiator; polished metals the worst. Color alone has no influence on radiation.

Fig. 225.

Fig. 226.



Reflection of heat resembles reflection of light. It is familiarly shown by holding a sheet of polished metal near the fire, at an angle; the heat will be reflected at a corresponding angle, upon the face, etc., of the observer. It is better illustrated by placing a red-hot ball in the focus of a parabolic mirror; the calorific rays impinging on the mirror will be reflected in straight lines. If another similar mirror be now properly adjusted opposite the first, and many feet distant, these rays falling on the surface will again be reflected so as to converge at its focus; and if a piece of phosphorus be placed at this spot, it will immediately be inflamed. It is a law that the best radiators are the worst reflectors, and *vice versâ;* but the power of absorbing heat is in direct proportion to

the radiating power; and it has been shown by Franklin's experiments with pieces of differently colored cloth placed upon the snow, to depend materially on the color—the darkest color causing the greatest melting of the snow beneath.

Transmission of heat.—By this is understood the passage of calorific rays through certain media, as air, water, glass, etc. Substances which transmit such rays are termed *transcalent* or *diathermanous.* It may be familiarly shown by interposing a piece of plate glass between a red-hot body and a parabolic mirror; while all the rays of *light* will pass through the glass, many of the rays of *heat* will be arrested by the glass, so that a very feeble heating effect is produced at the focus of the mirror. The only substance that is perfectly diathermanous is *rock salt;* other media, though entirely transparent, intercept the rays of heat to a greater or less extent.

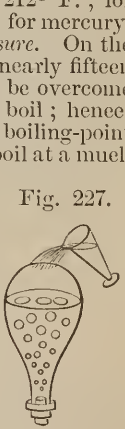
It has also been shown that rays of heat, like rays of light, are capable of *polarization.*

Vaporization.

Vaporization signifies the conversion of a solid or liquid into a vapor or gas, by means of heat. Vapors differ from gases only in being more easily compressed into liquids. Vaporization includes both *ebullition* and *evaporation.*

Ebullition or *boiling* is the rapid conversion of a liquid into a vapor; this rises to the surface of the liquid in the form of bubbles, which then burst with a slight noise. The point at which this occurs is named the *boiling-point;* and it is always constant for the same liquid under the same circumstances. It, however, varies considerably for different liquids: thus, for water it is 212° F.; for alcohol, 172°; for ether, 96°; for sulphuric acid, 620°; for mercury, 662°. The boiling-point is chiefly influenced by *pressure.* On the earth's surface, the atmosphere exerts a pressure of nearly fifteen pounds on every square inch; this pressure must first be overcome by the elasticity of the vapor of a liquid, before it can boil; hence, as the atmospheric pressure constantly varies, the boiling-point must equally vary: thus, water and other liquids will boil at a much lower temperature than 212° on the top of a mountain, or in a partially exhausted receiver. So constant is the ratio between the depression of the boiling-point, and the diminution of the atmospheric pressure, that it forms a good method of ascertaining the height of mountains—a fall of one degree F. being equivalent to an elevation of about 548 feet. Liquids boil *in vacuo* at a temperature 140° lower than in the open air. The influence of a diminished pressure in lowering the boiling-point of a liquid is well exhibited in the experiment called the *culinary paradox* (Fig. 227). A flask of water is made to boil for a few minutes until steam freely issues from the mouth, when it is firmly corked. On removing it from the heat, the ebullition, of course, ceases; but it recommences on simply pouring cold water upon it—the cold con-

Fig. 227.



densing the vapor, and thereby diminishing the pressure on the liquid.

On the other hand, the boiling point is much elevated by increasing the pressure. In this way water may be prevented from boiling by the pressure of its own vapor, being confined in a strong metallic vessel. The only limit to the degree to which water may be thus heated, is the capability of the vessel to bear the enormous pressure thus generated. It is on this principle that the *high-pressure* steam-engine acts. In it the steam is forced both before and behind the piston by means of sliding valves. In *low-pressure* engines, a vacuum is created before and behind the piston by means of a condenser, so that the piston is driven into a vacuum, instead of against the pressure of the atmosphere.

Others causes, besides pressure, that modify ebullition are *the nature of the vessel* and *the depth of the column of liquid.* The first of these depends upon the different degrees of attraction subsisting between the sides of the vessel and the liquid; the second, upon the increased pressure produced upon the lower stratum by a very tall column of liquid.

A cubic inch of water, in becoming steam under the ordinary pressure of the atmosphere, expands nearly into a cubic foot.

Evaporation differs from ebullition only in being a slower process, and in not being attended with the phenomena already described. It occurs at ordinary temperatures. All liquids (and some solids, as camphor) undergo evaporation, though unequally. It is influenced, (1) by extent of surface; (2) by temperature; (3) by the dryness of the atmosphere; (4) by a current of air; (5) by pressure. The effect of pressure is well seen by removing the air from a receiver under which ether is placed; the evaporation is so rapid as to produce the phenomena of ebullition.

Cold is always produced by evaporation, in consequence of the amount of heat rendered latent. The cold resulting from dropping a little ether upon the hand, or on the bulb of a thermometer, is a familiar instance of this. Water may be frozen under the exhausted receiver of an air-pump, either by the evaporation of ether surrounding it, or by its own evaporation.

Wollaston's *cryophorus*, or frost-bearer, consist of a glass tube, of the figure represented in the cut. The bulb contains water, the

Fig. 228.

rest of the space being filled with aqueous vapor. The empty extremity being put into a freezing mixture, the condensation of the vapor causes such a rapid evaporation from the surface of the water as very soon to freeze it.

The thermometrical point at which moisture is condensed from the air upon a cool surface is called the *dew-point;* it varies according to the temperature of the air; and especially according to the

amount of its moisture. *Hygrometers* are instruments for ascertaining the dampness of the atmosphere.

Specific Heat.

Capacity for Heat.—By this is meant the ratio of the heat of a body to its bulk or weight. Different bodies having the same temperatures, *i. e.*, the same *apparent* heat, contain, in reality, very different amounts of caloric.[1] Equal weights of different substances exposed for the same time to the same source of heat, do not acquire the same temperature ; some take a longer time than others to become hot. If equal weights of mercury and water be taken, it will be found that while the mercury rises 33°, the water rises only 1° ; the water is thus said to *have a capacity for heat* thirty-three times greater than mercury. There are several modes of ascertaining the specific heat of bodies: (1) by observing the quantity of ice melted by a given weight of the substance heated to a particular temperature ; (2) by noting the time required by a heated body to cool down to a certain point ; (3) by mixing together two substances of different temperatures and observing the resulting temperature. As water has the greatest capacity for heat (or the greatest specific heat) of all known substances, it is taken as the standard.

The specific heat of a body is always diminished by increasing its density, and *vice versâ;* thus, a piece of iron, when hammered, becomes hot from the liberation of its heat—its *capacity for heat* being lessened. The same thing occurs when a vapor is condensed into a liquid, or a liquid into a solid ; and *vice versâ.* The heat given out by suddenly compressing air is sufficient to ignite tinder, as is familiarly seen in the *fire-syringe.*

The spheroidal state signifies the peculiar shape which water and other liquids will assume, when projected upon a smooth, red-hot metallic surface. Instead of immediately escaping as vapor, the liquid will play upon the surface in spheroidal globules, until the temperature is reduced nearly to 212°, when it will suddenly explode into vapor. This is probably the cause of many boiler explosions ; the metal becoming red-hot, the water assumes a spheroidal condition, and no steam is generated ; but on suddenly cooling it down by the admission of more water, instantaneous explosion ensues, in consequence of the rapid evolution of steam.

Means of Producing Heat.—It must suffice simply to mention these here, viz.: *combustion, lenses and mirrors, friction, percussion, condensation, chemical combination, electricity, fermentation,* and *vitality.*

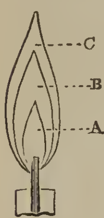
Combustion.

Incandescence is glowing heat ; a temperature so high as to render a body luminous. *Combustion* is intense *chemical action;* the combination of two or more elements, with the disengagement of heat. Ordinary combustion is the rapid union of the oxygen of the air

[1] This expression is *provisional* only ; but, as yet, no other sufficiently convenient terms have been found, in accordance with the dynamic theory of heat.

with the carbon and hydrogen of wood, coal, etc. But many other substances will burn in pure oxygen gas, as well as in chlorine, vapor of sulphur, and other active elements. The brightest flames are those which contain the densest vapors. A flame burning in the air (as that of a candle, lamp, or gas jet) is hollow, and comprises three portions. The dark part in the centre consists of volatile, combustible matter. Around this is the luminous cone, from which a deposit of soot (unburned carbon), will form on a cold body. Outside of this is the third cone, less luminous, but very hot.

Fig. 229.



The *blowpipe* flame presents two long, pointed cones; the inner one blue, and the outer somewhat yellow. Between the inner and outer cones is the *reducing* or *deoxidizing* part of the flame; just beyond the point of the outer cone is the *oxidizing* part. Very important use is made of the blowpipe in chemical analysis, especially that of mineral substances.

The temperature at which bodies take fire varies greatly. Phosphorus burns slowly in the air even without friction, at ordinary temperatures; and sulphur is ignited at a very moderate heat (560° F.). Magnesium and zinc will burn in the open air. Iron wire will do so, with great brilliancy, in pure oxygen gas. Slow combustion is considered, by most physiologists, to be the source of animal heat; the gradual oxidation of carbon, hydrogen, sulphur, and other elements within our bodies.

CHAPTER III.

LIGHT.

Theories of Light.

(1) The corpuscular or Newtonian theory supposed it to consist of infinitely small particles or corpuscles, thrown off by luminous bodies. (2) The undulatory theory makes it depend upon vibrations transmitted through a medium of extreme rarity, termed ether. The latter theory is generally accepted.

Light travels in straight lines, in every direction, with extreme velocity; it occupies about eight minutes in coming from the sun to the earth, which is at the rate of more than 180,000 miles in a second.

A *ray* is a single (imaginary) line of light; a *beam* is a collection of parallel rays; a *pencil* is a collection of convergent or divergent rays, as from the sun or a candle. The *intensity* of light is inversely as the square of the distance.

A ray of light falling upon a plane surface is either *reflected*, *transmitted*, or *absorbed*.

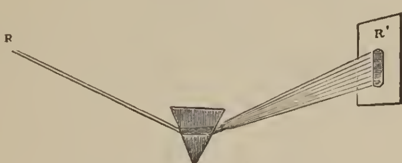
Reflection signifies that reaction which causes a ray of light, falling upon a bright, smooth surface, to be thrown back at an angle *which is always equal to the angle of incidence.* Mirrors are *plane* and *curved.* The *speculum*, *endoscope*, *laryngoscope*, and *ophthalmoscope* are examples of mirrors used in medical diagnosis.

Transmission of Light.

When a ray of light falls perpendicularly upon a transparent medium, it passes directly through it; if it falls at an angle, it is bent or *refracted* from the straight line. In passing from a rarer to a denser medium, as from the air into glass or water, the ray is bent *towards* a line perpendicular to the surface of the latter; but when it passes from a denser to a rarer medium, it is refracted *from* the perpendicular. Different substances possess different degrees of refractive power; generally speaking, the densest bodies refract most; the same is true also of combustible substances.

White light is compound, that is, it is made up of different colored rays, as may be proved by allowing a ray to pass through

Fig. 230.



an aperture in a darkened room, and interposing a glass prism. It will not only be refracted from its straight course, but will be decomposed into seven differently colored spaces, forming upon the screen a figure termed the *spectrum.* The lower color of the spectrum is red; the upper one, violet; the intermediate portions, commencing with the violet, being indigo, blue, green, yellow, and orange, each gradually shading off into the other. These were termed by Newton the *primary* or *prismatic colors*, from the impression that they were the elements of white, or common light.

Brewster's theory—the one at present generally adopted—is, that there are only *three* primary colors, viz., blue, yellow, and red; and that when these are mixed in definite proportion, white light will result. The *color* of objects results from the absorption (or arrest) by these bodies of certain rays, and the reflection of others. They appear *white* when they reflect all the rays; and *black* when they absorb all.

The greatest *illuminating* power of the spectrum is about its middle; the greatest *heating* power is in the red space, or just beyond it; the deoxidizing power is just outside the violet ray. The violet ray is the most refrangible; the red, the least so.

If the solar spectrum be viewed through the *spectroscope* (which consists essentially of a telescope so arranged as to receive the

spectrum), numerous dark lines, parallel with the edge of the prism, will be observed; these are termed *Fraunhofer's lines.* These lines are invariably fixed in reference to the colors of the spectrum, and are of the greatest use for purposes of measurement. When the spectrum is produced by artificial light, the result is different; if the source of light be incandescent platinum, or any other non-volatile body, no lines are observable; but if volatile substances be present, bright lines are observed in the spectrum, which are frequently highly characteristic of the substance.

The *spectrum-analysis*, for which we are chiefly indebted to MM. Kirchoff and Bunsen, is thus employed: a minute quantity of some volatile compound of the body to be examined is introduced on the loop of a platinum wire, into a Bunsen flame; this light passes through a slit in a disk, and then through a tube so as to fall upon a prism, by means of which the spectrum is formed, and is examined through the telescope from the other side. The different metals thus examined afford characteristic colored bands: thus, sodium always forms a yellow band; potassium a violet one; strontium and lithium, red, etc. The quantity that may thus be recognized is almost infinitesimal; the $\frac{1}{180000000}$th of a grain of sodium can be detected. Several of the new metals were discovered by this means; viz., cæsium, rubidium, indium, and thallium.

The *chemical* (actinic) effects of light are well marked; thus, a mixture of chlorine and hydrogen gases may be preserved for any length of time in the dark; but under the agency of light, a combination soon ensues. The blackening and decomposition of the salts of silver occur rapidly under the influence of light, as is familiarly seen in the art of photography. But the most remarkable chemical effect of light is witnessed in vegetation; where, under its agency, the leaves of growing plants have the power to decompose the carbonic acid of the air, appropriating the carbon to their own growth, and giving out the oxygen to the atmosphere.

Absorption of light occurs more in some bodies than in others. As a rule, those which absorb most radiant heat are the best absorbers of light. Color appears to influence it; thus, light-colored substances are less easily heated by the sun's rays than dark-colored ones. For this reason, light-colored garments are coolest in summer.

Fluorescence is an effect peculiar to certain substances (among them solution of sulphate of quinine), by which the refrangibility of the rays of light passing through them is diminished. Thus the color of the light may be changed, or rays extending beyond the limits of the visible spectrum, may be made luminous in the dark. *Double refraction* is when a ray of light passing through certain crystals, as Iceland spar, is split into two, one of which is refracted in the ordinary way, the other taking an extraordinary direction.

Another property of light is its capability of *polarization*. For an account of this the student is referred to treatises on Optics.

CHAPTER IV.

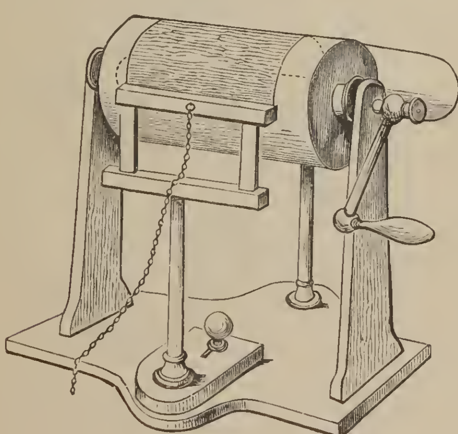
ELECTRICITY.

ELECTRICITY (from ελεκτρον, amber), is a force or property, believed to reside in all bodies, in a state of equilibrium, and to manifest itself only when this is disturbed. It may be excited in various ways, as, 1st, by *mechanical means* (frictional or statical electricity; 2d, by *chemical* action (dynamical or voltaic electricity); 3d, by *heat* (thermo-electricity); 4th, by *magnetism* (magneto-electricity); 5th, in *animals* (animal electricity).

Statical Electricity.

Electrical excitement is produced by rubbing glass, rosin, or amber, with silk or fur, when they will attract light bodies. There are two varieties or states of electricity: the *vitreous*, called also *positive*, which is manifested in glass; and the *resinous*, or *negative*, excited in resins. These may be shown by suspending a light pith ball, or feather, by a silken thread, and holding near to it a

Fig. 231.



glass tube, previously excited by rubbing with silk or fur; the body will be first *attracted* to the glass, but, after contact, it will be *repelled* in consequence of receiving electricity from the glass.

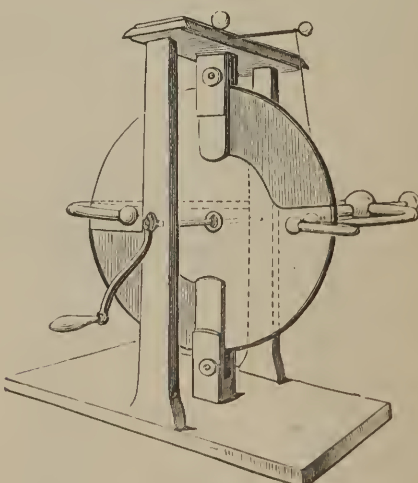
If now the rubber be presented to it, or a stick of resin, properly excited (being in a different electrical state), the body will be attracted. But again, after touching the resin, repulsion will occur, while it will be attracted to the glass.

This experiment establishes the law that "bodies similarly electrified repel each other; but dissimilarly electrified, they attract."

Electricians divide bodies into *electrics*, or *non-conductors*, and *non-electrics*, or *conductors*. Among the former are glass, rosin, and sulphur; among the latter are water, the metals, etc.

The essential parts of an *electrical machine* are, 1st, the *electric*, which is usually a glass plate or cylinder; 2d, the *rubber*, which is a stuffed cushion, covered with an amalgam of tin, zinc, and mercury, against which the electric is rubbed; 3d, the *prime conductor*, a metallic cylinder armed with a number of points for the collection of the electricity. The cushion and prime conductor should both be *insulated*, *i. e.*, supported on a glass pedestal. The cylinder, or plate, as it revolves against the rubber, becomes *positively* excited, and discharges its redundant (vitreous) electricity, by means of the points, into the prime conductor, which, being

Fig. 232.

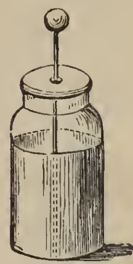


insulated, becomes surcharged, and will give off the excess to any body approaching it, with an audible snap and *spark*. The maximum effect is obtained when the rubber communicates with the earth by means of a chain.

The *Leyden jar* is an instrument for accumulating electricity. It depends upon the principle that a large amount of electricity, in

its two different states, may be accumulated on the two surfaces, without any return to equilibrium, on account of the non-conducting power of the glass. It consists of a thin glass jar, coated on both sides with tinfoil to within a few inches of the top; a wire, terminating in a metallic knob, communicates with the interior coating. When the outside coating is connected with the earth, and the knob is placed near the prime conductor of the machine, the inner and outer surfaces of the jar become respectively positive and negative. If, now, these two coatings be made to connect by means of a bent wire, the equilibrium is restored, a bright spark is perceived, along with a sharp snap; and if the human body be interposed so as to form part of the circuit, the *electric shock* is felt.

Fig. 233.

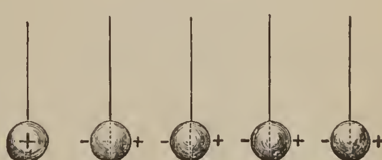


LEYDEN JAR.

The *electric battery* is a collection of Leyden jars, arranged in such a manner as to have all their inner and outer surfaces respectively connected together, by which great extent of surface and enormous accumulation of electricity are secured. The whole is discharged at the same moment, with, of course, a very powerful effect.

Electrical induction signifies the power possessed by an electrified body to produce, *or induce*, an opposite electric condition in a contiguous body. By virtue of this law, when an electrified body, as an excited glass tube, approaches a pith ball or feather, it immediately attracts it, because it has first *induced* in it an opposite electrical state. A series of globes suspended by silk threads, in the manner represented in the cut, will each become electric by *induction* when a charged body is brought near the end of the series. The positive and negative signs are intended to designate the states of electricity. In this way the phenomena of *thunder storms* are explained. Experiment has shown that the higher regions of the air are usually in a positive state. In cloudy or stormy weather, the clouds near the surface often appear in a negative state. In a thunder storm, the cloud and the earth may be compared to the two coatings of the Leyden jar, differently electrified, the cloud having induced an opposite state of electricity on the earth's surface. When the tension of the electricity becomes sufficiently strong to overcome the obstacle of the intervening air (representing the glass in the Leyden jar), the spark will pass, accompanied by thunder. The dangerous effects of lightning are much lessened by the use of *lightning-rods*, which are metallic conductors, usually iron or copper, terminating above in a point, or series of points,

Fig. 234.



and below passing to a considerable depth into the earth, *always* to moisture. The object of the *pointed* extremity is to conduct off the discharge silently.

Electroscopes and *electrometers* are instruments for indicating and measuring the electrical intensity. *Bennett's gold leaf electroscope* consists of two slips of gold leaf attached to a metallic cap placed on the top of a bell jar. On the approach of an electrified body, the leaves immediately diverge. There are other instruments known by the name of *quadrant electrometer*, *torsion electrometer*, *balance electrometer*, etc.

Fig. 235.

ELECTROMETER.

Theories of Electricity.

Franklin's theory maintains that it is a single fluid, pervading all bodies; that its equilibrium is liable to be disturbed by friction, etc.; and that when it is in excess, it is *positively* excited; when in deficiency, it is *negative;* and when it is in either of these states, there is a constant tendency to equilibrium. The other theory (Dufay's) supposes two fluids, one *vitreous*, because developed in glass; the other *resinous*, because especially manifested in resinous bodies; also that these two fluids exist in all substances, and neutralize each other, preserving an equilibrium; but that when this equilibrium is disturbed by friction, etc., one or the other kind of electricity is displayed. All electrical phenomena can be explained by either theory.

Dynamic, Voltaic, or Galvanic Electricity.

Here *chemical action* is the exciting cause. If two pieces of different metals be plunged into a liquid capable of acting on them unequally, the electric equilibrium is disturbed, the one acquiring a positive condition, the other a negative one. A piece of zinc and one of copper placed in a vessel of dilute sulphuric acid, will cause such a disturbance of the electrical equilibrium; all the particles of the water between the metals become *polarized*—their atoms of oxygen presenting towards the zinc, which then becomes *positive*, and the hydrogen atoms turning towards the copper, which also becomes *negative*. If now the two metals be made to connect by means of wires attached to them, an electric current is set in motion, the oxygen of the water combines with the zinc, while the hydrogen, being unable to unite with the copper, escapes in successive bubbles.

The *intensity* of the electricity thus developed is exceedingly feeble; but by arranging a number of single pairs in such a manner that the direction of the current shall be the same in each, the intensity will be much increased. On this principle the *pile of Volta*, and the *crown of cups* are contrived.

Volta's pile consists of a number of small plates of zinc and copper arranged in a pile, each pair being separated by a piece of cloth moistened with very dilute sulphuric acid, as seen in the figure. If the two terminal plates be now touched with wet hands, a prolonged electric shock will be experienced, the intensity of which

may be increased to almost any extent, by simply increasing the number of the plates.

Fig. 236.

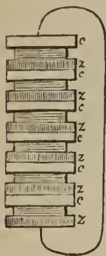
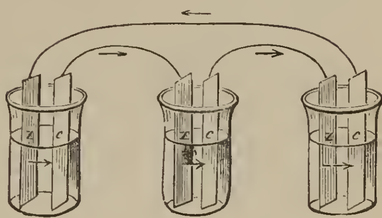


Fig. 237.

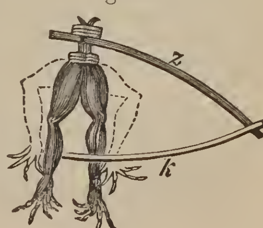


The *crown of cups* is similar in principle though different in form. It consists of any number of cups or glasses arranged in a row or circle, each containing a plate of copper and zinc, and some dilute acid. The copper of the first cup is connected by a wire with the zinc of the second, and so on; on causing the first and last plates to connect by means of wires, a discharge or current results.

When but a single pair of plates is used, with the interposed fluid, the arrangement is termed a *simple circuit;* when several pairs are employed, it is called a *compound circuit.* But however complex the arrangement may be, the principle is, in all cases, the same. The disturbance of equilibrium may be regarded as commencing at the surface of the most oxidizable metal, and thence propagated through the liquid to the least oxidizable metal; hence when isolated, the zinc end of the series is always negative, and the copper end positive. When the two extremities are connected, the current continues to pass from the copper to the zinc; so that, in fact, there are *two* currents, one *in* the battery, passing from the zinc to the copper; the other *out of* the battery, going from the copper to the zinc, as indicated by the arrows in the preceding figure.

The *quantity* of electricity set free by a galvanic arrangement should be distinguished from its *intensity;* the former is measured by its chemical effects, particularly its decomposing power, and depends on extent of surface; the latter, by the power of overcoming obstacles and passing through imperfect conductors; it depends on the number of plates. The energy of a Voltaic current is measured by the deflection of a magnetic needle.

Fig. 238.



Theories.—Galvani supposed the force to be developed in the animal upon which he operated—as when convulsions were produced in the limbs of a dead frog on touching the muscles and nerves with dissimilar metals; and that these merely served as conductors. Volta, on the other

hand, believed the electricity to be developed by the contact of the two metals. Subsequently, Faraday established the idea of *chemical action* as the true cause.

Effects.—(1) Physical—as deflagration of metals and the production of heat and light. The *electric light* is produced by bringing together two carbon points, fixed to the poles of a powerful battery; (2) Chemical—as the decomposition of compound bodies. By this means Davy discovered the alkaline metals. When a compound body in a liquid state is interposed between the poles of a battery, decomposition takes place according to a uniform rule; certain elements, as oxygen, chlorine, iodine, etc., appearing at the positive end of the battery, and others, as hydrogen, the metals, etc., at the negative end. Hence, the division of bodies into *electro-positive* and *electro-negative*, the former appearing at the negative, and the latter at the positive pole.

The *electrodes* (anode and cathode) or *poles* of a battery are the terminal points of the circuit where electrical phenomena are observed. The liquid undergoing decomposition by electricity is named an *electrolyte;* and the act of decomposition is *electrolysis.*

Ordinary batteries soon lose their power by use, and become inert. *Constant* batteries preserve their power for an indefinite time. Those most employed are Daniell's, Grove's, Bunsen's, Smee's, etc.

Magnetism.

This is a force or property residing in a native oxide of iron called *loadstone*, rendering it capable of attracting iron and some other metals. An *artificial magnet* consists of a bar or horseshoe of steel, which has been properly rubbed with a natural or another artificial magnet. The power of a magnet resides at the extremities, which are termed its *poles;* these are named the *north* or *marked* pole, and the *south* or *unmarked* pole. Opposite poles attract, while similar poles repel each other. If a magnet be broken into any number of pieces, each one will exhibit polarity, *i. e.*, will have a north and a south pole.

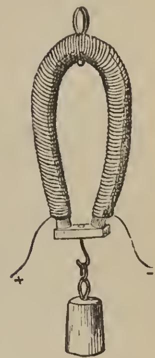
Magnetic induction (like electrical), is the property possessed by a magnet of producing an opposite magnetic state in a piece, or a number of pieces, of iron placed near to it. In this way *attraction* is brought about.

If a magnetic bar, or needle, be poised on a pivot, or suspended by a string, it will vibrate in a horizontal direction until it finally comes to rest in a line *nearly* north and south. The deflection from the exact north and south is termed the *variation of the compass.* If the bar be suspended so as to move in a vertical direction, it will assume a position dependent upon its proximity to the equator or the poles. This is termed the *magnetic dip.*

Electro-Magnetism.

If a galvanic current be made to pass around a magnetic needle, the latter will arrange itself across the current so that its axis will be perpendicular to the wire. If the direction of the current be reversed, the deflection will also be reversed. When an electric cur-

Fig. 239.



rent is passed at right angles to a piece of iron or steel, this acquires polarity, temporary in iron, permanent in steel. This effect is very much increased by causing the current to circulate a number of times around the bar, which soon acquires an extraordinary magnetic power; a horseshoe of soft iron, surrounded thus by a coil of insulated copper wire, becomes so highly magnetic, on receiving a galvanic charge, as to be capable of sustaining a very heavy weight. The *telegraph* is constructed upon this principle.

Induced or *secondary currents* are produced in insulated coils, placed near to, but not in contact with, the primary wire of the battery. On making contact with the battery, a feeble shock is felt on grasping the ends of the secondary wire; but on breaking it, the shock is marked, and sparks are obtained. *The Ruhmkorff Coil* gives powerful induced currents.

As electricity can produce a magnetic influence, so likewise can magnetism call into activity electric currents. If we introduce into a coil of wire the pole of a permanent magnet, a galvanometer will indicate the presence of a *momentary* current in the wire, the direction depending on the pole introduced. *Magneto-electric machines* are constructed on this principle. Opposite the poles of a powerful horseshoe magnet are placed two soft iron armatures, wrapped with insulated wire, and so arranged as to be rapidly rotated by means of a multiplying wheel. The armatures become magnetic by induction; the electricity induced by them in the wires is conveyed to the handles, and may give rise to sparks, shocks, and decomposition.

The earth is supposed to be a great magnet, having electric circuits traversing it at right angles, from east to west, and having its north and south poles corresponding to its respective geographical poles. Hence, the north pole of a magnet should really be considered its south pole, because opposite poles attract. For this reason, the poles of a magnet are now often named the *marked* and *unmarked* poles.

Thermo-Electricity.

As any obstruction to the electrical current develops heat, so any obstacle to the passage of heat develops electricity. Thus, if a common wire be bent or twisted, and heat applied, its molecular tension at that point being altered, it will deflect the needle of the galvanometer. If two dissimilar metals, as bismuth and antimony, be joined together, and the junction heated, electricity will be developed, as will be indicated by the needle. By arrranging a large number of such bars in a pile, heating the points of junction on one side, and keeping the others cool, a thermo-electric battery of great power is formed; and on connecting this with a galvanometer, a most delicate measurer of heat is obtained, far more delicate than any thermometer. Such an arrangement is named the *thermo-multiplier*.

Animal Electricity.—Statical electricity is exhibited in the electric eel and the electric ray. Dynamical electricity is witnessed in all living animals—different currents being developed, as in the muscles, between the skin and mucous membrane, etc.

Correlation of Forces.

Heat, light, electricity, magnetism, chemical and mechanical force are mutually convertible into each other, under changes of their material conditions. First established by Mayer, Grove, Colding and Joule, this truth has been amply illustrated by the experiments of many observers; especially Faraday, Helmholtz, Henry, and Tyndall. It is a reasonable inference, that the phenomena of all these forces are but different *modes of motion;* a medium being supposed to exist (called the universal *ether*) whose vibrations, reacting with those of ordinary substances, constitute the waves of light, the currents of galvanic electricity, etc. The same view has been extended to the *nerve-force* of animals; and even to the vital force; upon which subject, see *Physiology.*

PART II.

INORGANIC CHEMISTRY.

CHAPTER I.

GENERAL CONSIDERATIONS.

MATERIAL bodies are divided by the chemist into *simple* or *elementary*, and *compound.* Most bodies exist, in nature, in the compound state. Substances are called elementary, or simple, when they resist all efforts to decompose them. It is possible that some of these may hereafter prove to be compound. Before Davy's discovery, the alkaline metals were believed to be simple bodies.

The number of elements is about sixty-five; of which fifty are *metals*, and fifteen *non-metallic* bodies.

Chemical Affinity.

This is "the attraction exerted between molecules or particles of a different nature, at insensible distances, and attended with a change of properties." In water, and in sulphuretted hydrogen, for examples, the affinity is exerted between the oxygen and hydrogen in the one case, and between the sulphur and hydrogen in the other.

The first and most simple case of affinity is *simple combination*,

as where two different bodies, A and B, unite to form a compound, AB: thus, oxygen and hydrogen form water; copper and zinc form bronze; sulphuric acid and soda form sulphate of sodium.

The second case of affinity, called *single elective attraction*, is where two simple bodies, A and B, unite together to form a compound, AB; a third body, C, being added, decomposes the former, uniting with one of the elements, and forming a new compound, AC or BC; thus, potassa, being added to a solution of sulphate of magnesium, unites with the acid, and precipitates the magnesia. Water, added to the tincture of camphor, unites with the alcohol, and liberates the camphor.

The third case of affinity, called *double elective attraction*, is when two compound bodies, AB and CD, react upon each other, causing double decomposition, and producing two new compounds, AC and BD; thus, a solution of acetate of lead and sulphate of zinc will form acetate of zinc (in solution) and sulphate of lead (precipitated).

The fourth case of affinity is where two bodies being in combination, AB, a third body, C, being added in excess, combines with *both* the others, to form ABC; thus, ammonia, being added in excess to a solution of sulphate of copper, forms *ammonio-sulphate of copper.*

Circumstances which modify Chemical Affinity.—One of these is *heat;* thus, by heating mercury in the air, it will combine with oxygen; if the heat be much increased, they will be separated again. The metals will not combine together when cold; heated together to the fusing point, many of them readily unite to form *alloys.* Another modifying agent is *solution.* Many substances which, in the dry state, evince no tendency to unite, when wet combine with great power: *e. g.*, tartaric acid and carbonate of sodium. *Mechanical division*, by overcoming cohesion, greatly promotes chemical combination; *light* favors it: *e. g.*, a mixture of chlorine and hydrogen may be kept indefinitely in the dark, but they combine with explosive violence in the sunlight. The *nascent state* favors combination: thus, bodies which refuse to combine in their ordinary free state, will do so *in the act of being liberated from combination. Catalysis* or *presence* also favors combination in certain cases; that is, the presence of one body appears to promote combination between two others; itself, sometimes at least, being unaffected. *Degrees of solubility* affect the results of the mixture of different substances in the presence of water. Whenever, among the possible compounds of several elements mixed together, one is *more insoluble* than the rest, that one is always formed. Such, when deposited from a solution, is called a *precipitate.* Many processes of *testing*, in chemical analysis, depend upon this law. Again, whenever, among the possible results of the combination of elements mingled together, one is *volatile* at the temperature existing, that one is always formed by preference, escaping in the gaseous or vaporous state.

Changes accompanying Chemical Combination.—(1) of *color;* (2) *state*—as when two gases (oxygen and hydrogen) unite to form a liquid (water); or muriatic acid gas and ammonia unite to form a solid (sal ammoniac); (3) *temperature*—as water and sulphuric

acid when mixed in certain proportions elevate the temperature to 212° F.

Tables of affinity consist of series of substances placed in a column in the order of their affinity for any one substance at the head of the column, as follows :—

Sulphuric Acid.

Baryta,
Strontia,
Lime,
Potassa,
Magnesia,
Ammonia.

The atomic theory of Dalton is based upon the supposition that every body is divisible into ultimate particles termed *atoms*, which unite together always in certain definite proportions, to form various compound bodies. Of the *absolute* weight of these atoms we can know nothing ; their *relative* weights express their proportional or combining numbers, called also their *chemical equivalents.* Thus, the hydrogen atom being the lightest, the oxygen atom is found to be sixteen times heavier ; the iron atom fifty-six times heavier, and so on. Now, these numbers, expressing the *proportional weight* of the different atoms, or *the least combining proportion* of different bodies, have been named their "chemical equivalents," because in combination they can replace each other. For example, taking hydrogen as the unit (being the lightest), the equivalent of chlorine is 35.5 ; of bromine, 80 ; of phosphorus, 31, etc. ; that is, one part by weight of hydrogen unites with 35.5 of chlorine, and so on.

A molecule of a compound body, will, of course, be compound, as, a molecule of water, or of sulphuric acid. So also the *chemical equivalent* of a compound substance is the sum of the equivalents of its constituents : thus, the equivalent of water is 9 $(8 + 1)$, *old* notation ; according to the *new* notation, 18 $(16 + 2)$.

Synthesis, in chemistry, is the putting together of either elements or compounds, so as to cause them to unite and form a new substance.

Analysis is the decomposition of compounds, by definite processes. *Qualitative* analysis determines the nature of the substances present ; *quantitative* analysis the relative amount of each.

Laws of Chemical Combination.

1. *The Law of Definite Proportions.*—All bodies combine in fixed or definite proportions. This law insures the *identity* of all compound substances.

2. *The Law of Multiple Proportions.*—When one body is capable of combining with another in *more than one* proportion, these proportions bear a simple ratio to one another. This is illustrated according to the old notation in the series of compounds of nitrogen and oxygen, which is expressed by NO, NO_2, NO_3, NO_4, NO_5 ; here, the proportions of oxygen increase progressively by the multiple of 8 ; as nitrogen (14) with 8, 16, 24, 32, 40, respectively, of

oxygen, to form five distinct compounds. Under the new nomenclature, however, these compounds have respectively the formulæ N_2O, NO, N_2O_3, NO_2, and N_2O_5.

3. *The Law of Equivalents.*—This simply expresses the fact, already explained, that the numbers or chemical equivalents of bodies indicate the proportions *by weight* in which these several bodies will combine with each other.

Chemical Nomenclature.

As the object of nomenclature is to indicate the nature of a substance by its name, many of the elements have received names expressive of some of their striking properties ; thus, *oxygen*, from two Greek words signifying "to produce an acid," because it was originally regarded as the sole acidifying principle ; *hydrogen*, from two words signifying "to form water ;" others again derive their names from words expressive of color or smell, as *chlorine*, *iodine*, *bromine*, *ozone*.

The compounds of oxygen are named *acids* or *oxides* according as they do or do not possess acidity. Acids derive their names from the substance acidified by oxygen ; thus, sulphur, carbon, and phosphorus form with oxygen sulphuric, carbonic, and phosphoric *acids*. The termination is usually in *ic;* but if the substance be capable of forming more than one acid, the name of the compound containing the less oxygen is made to terminate in *ous ;* thus, sulphurous and phosphorous acids. When the same substance forms several acids with oxygen, the Greek prefix *hypo* (under) is used ; thus, hyposulphurous and hyponitrous acids are those containing respectively less oxygen than nitrous and sulphurous acids. The particle *hyper* or *per* is employed to express the maximum of oxidation, as *hyperchloric* and *permanganic* acids.

Different *oxides* of the same metal are distinguished by the numerals prefixed. The oxide containing a single equivalent of the metal and oxygen is named the *protoxide ;* that containing the greatest amount of oxygen is designated the *peroxide*. The intermediate ones are expressed by the numerals *deut*oxide or *bin*oxide ; *ter*oxide or *trit*oxide, etc. The numerals *dis*, *tris*, etc., have denoted oxides containing an equivalent of oxygen with two, three, etc., of the metal, as the *di*oxide of copper. A *sub*oxide denotes an oxide containing less oxygen than a protoxide. The application of these names has undergone modification in the new system of nomenclature ; as will be seen in examples presented, with both the old and the new names, in the course of this manual.

The termination of names of other compounds is made to conform as nearly as possible to those of the oxides : thus the non-acid compounds of chlorine, bromine, iodine, fluorine, etc., are named chlor*ides*, brom*ides*, etc. The same is generally true, also, of the compounds of the inflammables, sulphur, phosphorus, carbon, etc. ; they are named sulph*ides*, phosph*ides*, etc. ; although, sometimes, sulphur*ets*, phosphur*ets*, etc.

The nomenclature of the *salts* is made to depend on the termination of their acid ; thus, acids ending in *ous* form salts ending in *ite; e. g.*, sulphurous and nitrous acids form sulph*ites* and nitr*ites;*

acids terminating in *ic* form salts ending in *ate*: thus, sulphuric and nitric acids give us sulph*ates* and nitr*ates*.

A *neutral* salt (where the acid and base neutralize each other) is simply named from its acid, as a *sulphate*, a *carbonate*, a *nitrate*, etc. If it contains two equivalents of acid (a *supersalt*), it is called a *bi*sulphate, *bi*carbonate, etc.; if it contains two equivalents of base (a *subsalt*), it is named a *di*sulphate, etc.

The term *sesqui* (one and half) is used to indicate the relation of 1 to $1\frac{1}{2}$, or of 2 to 3: thus, sesquioxide of iron is a compound of two of iron and three of oxygen.

The generic part of the name of a compound is usually formed from the ingredient which is most electro-negative: thus, of compounds of oxygen, chlorine, iodine, sulphur, etc., with each other, it has been common to say oxide of chlorine (or chlorine oxide), chloride of iodine, iodide of sulphur; and not chloride of oxygen, iodide of chlorine, sulphide of iodine, etc. It is often, however, very difficult to apply appropriate names to the highly complex bodies of the organic series; in which case, more particularly, the use of *symbols* or chemical signs is very useful.

Chemical Symbols.—Every elementary substance is designated by the first letter of its Latin name, in capital, or by this first letter conjoined with a second small one which is characteristic: thus, Oxygen, O; Hydrogen, H; Chlorine, Cl; Carbon, C: Silver, (argentum), Ag; Gold (aurum), Au; Iron (ferrum), Fe, etc It is always understood that these symbols express *one equivalent* of the substance designated.

Combination between bodies is expressed by a mere juxtaposition of their symbols, or sometimes by interposing the sign +: thus Water is expressed either by HO, or H + O (new notation, H_2O, or $H_2 + O$); Hydrochloric Acid by HCl; Protoxide of Iron (Iron Monoxide) by FeO. When more than one equivalent is intended, the number is either prefixed to the symbol or else is placed after it: thus, Sulphuric Acid (Sulphuric Anhydride of the new system), S + 3O, or (preferably) SO_3. Sometimes other abbreviations are employed.

A number placed before a compound multiplies all that follows in that compound: thus, $3(Fe_2O_3,3SO_3)$, *old notation*, signified three equivalents of the sulphate of the sesquioxide of iron, and $5(Al_2O_3, 3SO_3 + KO,SO_3)$ five equivalents of potash alum (sulphate of alumina and potassa).

IDEAS OF MODERN CHEMISTRY.

The ancients recognized the existence of different kinds of matter in the solid, liquid, and aeriform conditions. They also observed, and applied in their arts, many of the changes produced by mingling various substances together. Archæologists speak of the ages of *stone*, *bronze*, and *iron*; as representing the early progress of men in successively utilizing the different valuable materials derivable from the earth. In ancient Egypt, besides metallurgy and the making of glass, very permanent colors were manufactured and employed. The Arabians introduced chemistry into Europe; and, during the middle ages, the pursuit of the impracticable ob-

jects of alchemy was attended by many useful incidental discoveries. Men were still, however, for a long time deluded with the idea of the *transmutability* of all, even elementary, substances. Scientific chemistry could only begin to be realized when *definiteness* of composition and of reactions was shown to afford a basis for experiment and calculation. Homberg, in 1699, was probably the first to ascertain that a certain weight of an acid was required to saturate an alkaline carbonate, so as to make a neutral salt.

Modern chemistry may be regarded as dating from the attempts of Wenzel (1777) and Richter (1794) to establish a series of *combining equivalents* for the substances then known. The discovery, near the end of the 18th century, of the composition of the atmosphere and of water, muriatic acid, etc., along with the many truly philosophic labors of Lavoisier and his associates, caused great advances. But Dalton's introduction (1804) of the *law of multiple proportions*, and afterwards of the *atomic theory*, was an essential step towards further progress.

Gay-Lussac (1808) discovered the remarkably simple law of the *combination of gases by volume* in definite proportions. This may be exemplified as follows: I. 2 volumes of hydrogen combine with 1 volume of oxygen to form 2 volumes of aqueous vapor. II. 2 volumes of nitrogen combine with 1 volume of oxygen to form 2 volumes of protoxide of nitrogen. III. 3 volumes of hydrogen combine with 1 volume of nitrogen to form 2 volumes of ammoniacal gas. IV. 1 volume of nitrogen combines with 1 volume of oxygen, forming 2 volumes of binoxide of nitrogen. V. 1 volume of chlorine combines with 1 volume of hydrogen to form 2 volumes of hydrochloric acid gas.

It follows that, if the *combining proportions* of bodies indicate the *weight of their atoms*, this simple relation of volumetric combination proves the *relative weights of these volumes* (*i. e.* the density or specific gravity of the gases) to represent their *relative atomic weights*. One volume of chlorine unites with one volume of hydrogen; but the former volume weighs 35.5 times as much as the latter; hence the relative atomic weights of the two must be as 35.5 is to 1. And, since chlorine is not found to combine with other elements in any smaller proportion, we may call 35.5 its *atomic weight*. Of course this principle cannot be *directly* applied to substances not capable of being vaporized; but, with many of these, their volatile compounds afford indirect means of using it. Four exceptions to this law are met with; *phosphorus* and *arsenic* have vapor densities twice as great, and *mercury* and *cadmium* vapor densities half as great, as their atomic weights; the latter being ascertained by finding their smallest combining proportion with other bodies. For these exceptions, tenable explanations have been proposed, by Wurtz and others.

From the above facts concerning combination by volume, Avogadro[1] deduced (in 1811) the inference, that *equal volumes of gases contain the same number of atoms.* With compound gases, this expression requires to be modified; by substituting the word *molecules* for *atoms:* equal volumes of gases contain, under the same conditions of temperature and pressure, the same number of *molecules.*

[1] And, not long after, Ampère.

A molecule is the smallest particle of any substance capable of existing in the free state. An atom is defined to be the smallest conceivable particle of any substance, incapable of further chemical division.

Berzelius (from 1807) extended greatly the acquaintance of chemists with the equivalents of the different elements; of which a number had been determined by Dalton and Wollaston. In 1815, Berzelius introduced the method of symbolic notation (by letters and figures) now universally employed.

In 1819 Dulong and Petit announced the general fact that *the specific heats of simple bodies are in inverse ratio to their atomic weights;* so that, when these quantities are multiplied together, the product is a constant quantity. It follows that the atoms of different simple bodies possess the same specific heat. The only exceptions to this law are *carbon*, *silicon*, and *boron;* and these exceptions can be sufficiently well explained away.

Mitscherlich, in 1820, discovered the existence of *isomorphism* in a number of substances, simple and compound; and this similarity of form (in crystallization) was inferred to show, generally, similarity of atomic constitution. Examples of isomorphism are, the oxides of potassium, sodium, and ammonium; alumina and iron sesquioxide; magnesia and zinc oxide; the carbonates of calcium, magnesium, manganese, iron, and zinc. Conclusions in regard to the composition of some of these bodies have been reached by means of this fact.

A very important contribution to chemical discovery and philosophy was made by those inquiries into the effects of electricity upon chemical action, in which the most memorable event was the isolation of potassium by galvanic *electrolysis*, in the hands of Sir Humphry Davy (1807). Berzelius elaborated, on the basis of such observations, the *electro-chemical* theory; which was also ably supported and illustrated by Robert Hare. *Dualism* took strong hold of the minds of chemists at this time; chemical combinations were regarded as *additions*, making binary compounds, even when several elements were engaged. Thus, sulphur and oxygen make together sulphuric acid. Potassium and oxygen unite to form potassa. Sulphuric acid and potassa combine to form a salt, sulphate of potassa. Sulphate of potassa again unites with sulphate of alumina, producing alum, a double salt. All these, successively, were regarded by Berzelius as *binary* compounds. When any such compound was, in solution, decomposed by a current of electricity, it was believed that the most electro-negative element (or simpler compound), was always given off at the positive pole; and the most positive element at the negative pole. That such polar relations do exist, and that all the elements and compound bodies may be classified accordingly, is still universally admitted. But that compound bodies (*e. g.* salts) always "split up" in the one way, as if dually composed, is not now allowed by chemists generally.

One great fact has been long recognized, namely, that of *isomerism* (*i. e.*, two or more bodies having the same elements, in the same proportion, yet with some difference of properties), which shows that not only the *kind* and *number* of atoms or molecules in a body determine its characters, but also their *arrangement* (*urea* and *cyanate*

of ammonium well exemplify isomerism). Dumas, Gerhardt, and Laurent created an era in chemical thought, by establishing the frequency of *substitution* (instead of addition) in the changes of composition which occur amongst bodies, inorganic and organic. This (says Wurtz) was the commencement of the "new chemistry." Substitution was, as an idea, found to be the master-key of many problems. Instead, for instance, of supposing sulphate of potassa to be formed by the union of sulphuric acid, previously dissolved in water, with potassa as such, how easy it is to regard sulphuric acid as a compound of sulphur, oxygen, and *hydrogen*, which, in the presence of potassa, *exchanges* its hydrogen for the metal *potassium*. (Present formula, $SO_4H_2 + 2KHO = SO_4K_2 + 2H_2O$.) In organic chemistry this theory of substitution has become fundamental and indispensable.

But an essential change soon followed, in the conception of the condition of even the most familiar elements in the free state. Reverting to volumetric combinations, it was remarked that, when 1 volume of hydrogen unites with 1 volume of chlorine, 2 volumes of hydrochloric acid gas result. According to Avogadro's law, then, if each volume of a simple element contains the same number of atoms, and each volume of a compound gas has the same number of molecules, since every molecule of the product of combination, hydrochloric acid, consists of 1 atom of hydrogen and 1 of chlorine, there must have been *atoms* enough of each of the elements present, to *double* the number of *molecules* in each volume.

Hence results the formula, $HH + ClCl = 2HCl$.[1] In other words, *every molecule of hydrogen, or of chlorine* (and so of most other simple bodies) *consists of two similar atoms united together;* making, so to speak, a hydride of hydrogen, a chloride of chlorine, etc. Thus *every* decomposition becomes, in part at least, a process of substitution. Atoms, upon this view, never exist apart; but only molecules, composed of atoms of one, two, or more elements combined together.

In accordance with the considerations so far set forth, the advocates of what was called by Gerhardt the "unitary" system proposed the doubling of the previously accepted equivalents of a number of the elements; notably, of oxygen, sulphur, selenium, tellurium, carbon, silicon (silicium), aluminium, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, platinum, tin, zinc, etc.

From the theory of substitution to that of *types*, or *homologous series* of compounds, was a natural and important advance; first made extensively, in organic chemistry. Wöhler's artificial synthesis of urea (1828), followed by many other brilliant syntheses of complex natural products, especially by Berthelot, assisted materially in this progress. The great *representative* types are, HH, HCl, H_2O, H_3N, H_4C; *i. e.*, the hydrogen type; that of hydro-

[1] If one cubic inch of H contain x number of molecules, and each cubic inch of Cl the same number, then, when 2 cubic inches of HCl are formed, containing $2x$ molecules, each with an atom of H and one of Cl, there must have been $2x$ atoms of each simple gas present.

chloric acid; of water; of ammonia; and of marsh gas or carburetted hydrogen.

Wurtz, Hofmann, Williamson, and many others, have now given definite form to this conception of typical compounds; which has made order possible where, otherwise, all would have been confusion. The *alcohols*, *ethers*, *organic acids*, etc., thus range themselves in a symmetrical classification, capable of study and generalization. The idea of *condensed* types is also important, but cannot be here dwelt upon.[1]

The last great leading ideas of recent chemistry are those of *atomicity* and *quantivalence*. The former of these terms is not used precisely in the same way by all writers; but, practically, the two phrases may be considered to be synonymous. We may illustrate their meaning as follows: 1 volume of chlorine combines with 1 volume of hydrogen; (theoretically) 1 atom of chlorine, weighing 35.5, combines with 1 atom of hydrogen, weighing 1. Also, 1 volume (or atom) of oxygen unites with 2 volumes (or atoms) of hydrogen (forming water, H_2O). Further, 1 volume (or atom) of nitrogen unites with 3 volumes (or atoms) of hydrogen (making ammonia, NH_3). Here the *combining* and *saturating power* of 1 atom of nitrogen is shown to be three times, and that of 1 atom of oxygen twice, as great as that of 1 atom of chlorine. Carbon unites with hydrogen in the proportion of 4 atoms of the latter to 1 of the former, making CH_4 (marsh gas). Carbon also combines with oxygen, 1 atom of the former to 2 atoms of the latter, in CO_2 (carbonic acid gas). Here 2 atoms of oxygen are equivalent in combining or saturating power to 4 of hydrogen. In other words, the *quantivalence* of chlorine (hydrogen being the standard or test) may be represented by 1; that of oxygen, by 2; of nitrogen, by 3; and of carbon, by 4. A corresponding expression for this is, that chlorine and hydrogen are *univalent* elements; oxygen *bivalent;* nitrogen *trivalent;* and carbon *quadrivalent*. In perchloride of phosphorus, PCl_5, we find phosphorus to be *quinquivalent;* and other elements are, occasionally at least, *sexivalent* and *septivalent* in combination. Names from the Greek are used to signify the same differences: Hydrogen and chlorine are called *monads;* oxygen, sulphur, zinc, and copper are *dyads;* nitrogen, boron, bismuth, and gold (among other elements) are *triads;* carbon, silicon, tin, and lead are *tetrads;* vanadium, and sometimes phosphorus, are among the *pentads;* molybdenum, iron, cobalt, and nickel are instances of *hexads;* and a few *heptad* combinations occur.

In substitution, the displacement of one element (or compound radical) by another, conforms to their relative equivalence or

[1] See Wurtz, Introduction to Chemical Philosophy, Crookes' translation, p. 82. Some other important facts and theoretical considerations cannot be here stated and explained for want of room. Among these are, the *kinetic theory of gases* (Clausius); the transitional state occurring between the liquid and gaseous conditions of many bodies (Andrews); and the facts of *dissociation* (Deville). The last term (dissociation) may be defined to mean the gradual, partial, or temporary chemical separation of the elements of a gaseous compound, under an elevated temperature; these elements recombining when the temperature is lowered. See, also, The New Chemistry, by J. P. Cooke, Jr., 1874.

quantivalence. If iodine be displaced in a compound by chlorine, 1 atom of the latter replaces 1 atom of the former. When chlorine is replaced by oxygen, 1 atom of oxygen takes the place of 2 atoms of chlorine. If substituting nitrogen, 2 atoms of oxygen would replace 3 atoms of nitrogen, etc. Such displacements, however, do not occur indefinitely; but in certain series (types) as already mentioned.

More than one degree of quantivalence is possible, under different conditions, in the same element. Hydrogen is always univalent; *i. e.*, a monad. Copper is always a dyad; silver, a tetrad; tantalum, a pentad. But chlorine, in some compounds, appears to act as a triad; in others as a pentad; sometimes even as a heptad. Carbon may be either a dyad or a tetrad. Sulphur is in some combinations a dyad, in others a tetrad, in others, again, a hexad.

It is to be observed that, in each of these cases, an element may be *monad*, *triad*, *pentad*, or *heptad*, or again it may be *dyad*, *tetrad*, or *hexad;* but never both monad and dyad, or triad and tetrad, etc. Elements may therefore be divided into those whose quantivalence is represented by odd numbers (*perissads*) or those which have it represented by even numbers (*artiads*). It is often convenient to indicate these peculiarities by signs: thus, in water, we have $\overset{\mathrm{I}}{H_2}\overset{\mathrm{II}}{O}$; in ammonia, $\overset{\mathrm{III}}{N}\overset{\mathrm{I}}{H_3}$; in marsh gas, $\overset{\mathrm{IV}}{C}\overset{\mathrm{I}}{H_4}$; in perchloride of phosphorus, $\overset{\mathrm{V}}{P}\overset{\mathrm{I}}{Cl_5}$. The highest combining power of an element is understood to determine its atomicity.

Saturation exists when all the combining capacities or affinities of an element are satisfied. Water, H_2O, is a saturated molecule. But, if an atom of hydrogen be abstracted, we have HO, with one affinity of the oxygen *unsatisfied*. Such a compound molecule exhibits a different disposition in regard to new combinations from that of the saturated compound from which it came. It becomes a *compound radical; e. g.*, HO is the radical *hydroxyl*. So, also, when from the saturated hydride of ethyl, C_2H_6, there is taken 1 atom of hydrogen, we have the non-saturated compound radical ethyl, C_2H_5.[1] Another unsaturated compound or compound radical is CN, *cyanogen;* another, $NH_3—H = NH_2$, *amidogen*. The atomicity of any compound radical depends upon the number of unsatisfied affinities (sometimes called "free bonds") of its elements. Radicals of *uneven* atomicity never exist in the free state, *i. e.*, cannot be isolated. Radicals whose atomicity is *even* (as ethylene, C_2H_4, or carbonyl, CO) can exist free, and can directly combine with elements.

The following table (from Attfield) exhibits the quantivalence of a number of common simple and compound radicals.

[1] It must be remembered that carbon is in some compounds *bivalent;* in others *quadrivalent.*

Univalent Radicals or Monads.		Bivalent Radicals or Dyads.		Trivalent Radicals or Triads.	
Acidulous.	Basylous.	Acidulous.	Basylous.	Acidulous.	Basylous.
H	H	O	Ca	PO_4	As
Cl	K	SO_4	Mg	BO_3	Sb
I	Na	CO_3	Zn	$C_6H_5O_7$	Bi
HO	NH_4	C_2O_4	Cu	AsO_3	Fe^{iii} (ic)
NO_3	Ag	$C_4H_4O_6$	Hg(ic)	AsO_4	or
$C_2H_3O_2$	Hg(ous)	S	Fe(ous)	$C_4H_3O_5$	Fe^{vi}_2(ic)

Partial saturation of the affinities of the atoms of an element in a compound may be explained (Kekulé) by the *mutual* partial union of different atoms of the *same* element. In the saturated compound C_2H_6, for instance; of the 8 units of chemical affinity (*chemical force, chemism*) belonging to 2 atoms of carbon, 2 units may be mutually satisfied, leaving 6 only free.

$$\begin{array}{l} H\diagdown \qquad \diagup H \\ H-C—C-H \\ H\diagup \qquad \diagdown H \end{array} \quad \text{instead of} \quad \begin{array}{l} \quad \diagup H \quad \diagup H \\ C-H \; C-H \\ \quad \diagdown H \quad \diagdown H \end{array}$$

Sometimes *graphic* (diagrammatic) or *glyptic* (modeled) formulæ are employed to illustrate rational views of the atomic arrangement of compounds; but it is important to bear in mind that all such are only crude and insufficient aids to our attempts to conceive the real molecular structure of bodies.

Much more remains to be done, in the application of the principles which we have endeavored briefly to present, before chemistry can be perfected as a science. For the full development of the very great advances already made, the student must be referred to extended treatises.

After all (as remarked by Wurtz), the "new chemistry" is only a development of the chemistry of Lavoisier, who flourished in the latter part of the last century. Its modifications have been those of a continuous progress; not of a *revolution*, but of an *evolution*.

Electro-Chemical Relations of the most Important Elements.

Negative End.

Oxygen,
Sulphur,
Nitrogen,
Fluorine,
Chlorine,
Bromine,
Iodine,
Selenium,
Phosphorus,
Arsenic,
Chromium,
Boron,
Carbon,
Antimony,
Silicon,
Hydrogen,
Gold,
Platinum,
Mercury,
Silver,
Copper,
Bismuth,
Tin,
Lead,
Cobalt,
Nickel,
Iron,
Zinc,
Manganese,
Aluminium,
Magnesium,
Calcium,
Strontium,
Barium,
Lithium,
Sodium,
Potassium.

Positive End.

Atomic Weights.

Hydrogen = 1.

Oxygen,	O.	Old. 8.	New. 16.	Oxygen,	O.	Old. 8.	New. 16.
Aluminium,	Al.	13.7	27.4	Mercury,	Hg.	100.	200.
Antimony,	*Sb.*	122.	122.	Molybdenum,	Mo.	48.	96.
Arsenic,	*As.*	75.	75.	Nickel,	Ni.	29.	58.
Barium,	Ba.	68.5	137.	*Nitrogen,*	*N.*	14.	14.
Bismuth,	*Bi.*	210.	210.	Osmium,	Os.	100.	200.
Boron,	*B.*	11.	11.	Oxygen,	O.	8.	16.
Bromine,	*Br.*	80.	80.	Palladium,	Pd.	53.	106.
Cadmium,	Cd.	56.	112.	*Phosphorus,*	*P.*	31.	31.
Cæsium,	*Cs.*	133.	133.	Platinum,	Pt.	98.7	197.4
Calcium,	Ca.	20.	40.	*Potassium,*	*K.*	39.1	39.1
Carbon,	C.	6.	12.	Rhodium,	Ro.	52.	104.
Cerium,	Ce.	45.7	91.3	*Rubidium,*	*Rb.*	85.4	85.4
Chlorine,	*Cl.*	35.5	35.5	Ruthenium,	Ru.	52.	104.
Chromium,	Cr.	26.1	52.2	Selenium,	Se.	39.5	79.
Cobalt,	Co.	30.	60.	Silicon,	Si.	14.	28.
Columbium,	*Cb.*	94.	94.	*Silver,*	*Ag.*	108.	108.
Copper,	Cu.	31.7	63.4	*Sodium,*	*Na.*	23.	23.
Didymium,	D.	47.5	95.	Strontium,	Sr.	44.	88.
Erbium,	E.	56.3	112.6	Sulphur,	S.	16.	32.
Fluorine,	*F.*	19.	19.	*Tantalum,*	*Ta.*	182.	182.
Glucinum,	Gl.	4.6	9.2	Tellurium,	Te.	64.	128.
Gold,	*Au.*	197.	197.	Terbium,	Tb.	37.7	75.4
Hydrogen,	*H.*	1.	1.	*Thallium,*	*Tl.*	204.	204.
Indium,	In.	56.7	113.4	Thorium,	Th.	59.2	118.4
Iodine,	*I.*	127.	127.	Tin,	Sn.	59.	118.
Iridium,	Ir.	99.	198.	Titanium,	Ti.	25.	50.
Iron,	Fe.	28.	56.	Tungsten,	W.	92.	184.
Lanthanum,	La.	46.	92.	Uranium,	U.	60.	120.
Lead,	Pb.	103.5	207.	*Vanadium,*	*V.*	51.3	51.3
Lithium,	*Li.*	7.	7.	Yttrium,	Y.	30.8	61.6
Magnesium,	Mg.	12.	24.	Zinc,	Zn.	32.5	65.
Manganese,	Mn.	27.5	55.	Zirconium,	Zr.	44.8	89.6

The Perissads (univalent, trivalent, etc.) are printed in Italics, the Artiads (bivalent, quadrivalent, etc.) in Roman.

Quantivalence of the most Important Elements.

Monads:

- Hydrogen.
- Chlorine, I, III, V, VII.
- Iodine, I, III, V, VII.
- Bromine, I, III, V, VII.
- Fluorine.
- Potassium, I, III, V.
- Sodium, I, III.
- Lithium.
- Silver, I, III.

Dyads:

- Oxygen.
- Sulphur, II, IV, VI.
- Calcium, II, IV.
- Barium, II, IV.
- Magnesium.
- Zinc.
- Mercury.
- Copper.

Triads:
Nitrogen, I, III, V.
Phosphorus, I, III, V.
Boron.
Arsenic, I, III, V.
Antimony, III, V.
Bismuth, III, V.
Gold, I, III.

Tetrads:
Carbon, II, IV.
Silicon.
Tin.
Aluminium.
Platinum, II, IV.
Lead, II, IV.

Pentads:
Columbium.
Tantalum.
Vanadium, III, V.

Hexads:
Molybdenum, II, IV, VI.
Tungsten, IV, VI.
Osmium, II, IV, VI.
Chromium, II, IV, VI.
Iron, II, IV, VI.
Manganese, II, IV, VI.
Cobalt, II, IV.
Nickel, II, IV.

The following Table, illustrative of Types, is slightly modified from one given by Gerhardt.

	Positive Extremity.	Intermediate.	Negative Extremity
Hydrogen type $\left.\begin{matrix}H\\H\end{matrix}\right\}$	$\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}$ Ethyl $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}$ Hydride of ethyl	$\left.\begin{matrix}CH_3\\C_2H_3O\end{matrix}\right\}$ Acetone	$\left.\begin{matrix}C_2H_3O\\H\end{matrix}\right\}$ Aldehyde. $\left.\begin{matrix}C_2H_3O\\C_2H_3O\end{matrix}\right\}$ Acetyl.
Hydrochloric Acid type $\left.\begin{matrix}H\\Cl\end{matrix}\right\}$	$\left.\begin{matrix}C_2H_5\\Cl\end{matrix}\right\}$ Hydrochloric ether		$\left.\begin{matrix}C_2H_3O\\Cl\end{matrix}\right\}$ Chloride of acetyl.
Water type $\left.\begin{matrix}H\\H\end{matrix}\right\}O$	$\left.\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\right\}O$ Ether $\left.\begin{matrix}C_2H_5\\H\end{matrix}\right\}O$ Alcohol $\left.\begin{matrix}CH_3\\C_2H_5\end{matrix}\right\}O$ Ethylmethylic ether	$\left.\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}\right\}O$ Acetic ether	$\left.\begin{matrix}C_2H_3O\\H\end{matrix}\right\}O$ Acetic acid. $\left.\begin{matrix}C_2H_3O\\C_2H_3O\end{matrix}\right\}O$ Anhydro's acet. acid. $\left.\begin{matrix}C_2H_3O\\C_7H_5O\end{matrix}\right\}O$ Acetate of benzoyl.
Ammonia type $\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$	$\left.\begin{matrix}C_2H_5\\H\\H\end{matrix}\right\}N$ Ethylamine $\left.\begin{matrix}C_2H_5\\C_2H_5\\H\end{matrix}\right\}N$ Diethylamine $\left.\begin{matrix}C_2H_5\\C_2H_5\\C_2H_5\end{matrix}\right\}N$ Triethylamine		$\left.\begin{matrix}C_2H_3O\\H\\H\end{matrix}\right\}N$ Acetamide.

NEW FORMULÆ OF SOME OF THE MOST IMPORTANT COMPOUNDS.

Water, H_2O.
Sulphuric acid, H_2SO_4.
Sulphurous acid, H_2SO_3.
Sulphuretted hydrogen, H_2S.
Nitric acid, HNO_3.
Nitrous acid, HNO_2.
Phosphoric acid, H_3PO_4.
Boracic acid, H_3BO_3.
Silicic acid, H_4SiO_4.
Oxalic acid, $H_2C_2O_4$.
Acetic acid, $HC_2H_3O_2$.
Tartaric acid, $H_2C_4H_4O_6$.
Arsenious acid, H_3AsO_3.
Arsenic acid, H_3AsO_4.
Potassium monoxide, K_2O.
" dioxide, K_2O_2.
" hydrate, KHO.
Sodium monoxide, Na_2O.
" dioxide, Na_2O_2.
" hydrate, $NaHO$.
Calcium monoxide, CaO.
" hydrate, CaH_2O_2.
Aluminium oxide, Al_2O_3.
" trihydrate, $Al_2H_6O_6$.
Cuprous oxide, Cu_2O.
Cupric oxide, CuO.
Mercurous oxide, Hg_2O.
Mercuric oxide, HgO.
Mercurous chloride, Hg_2Cl_2.
Mercuric chloride, $HgCl_2$.

Ferrous oxide, FeO.
Ferric oxide, Fe_2O_3.
Ferroso-ferric oxide, Fe_3O_4.
Potassium carbonate, K_2CO_3.
" bicarbonate, $KHCO_3$.
" nitrate, KNO_3.
" sulphate, K_2SO_4.
" chlorate, $KClO_3$.
" bichromate, K_3OCrO_3.
" permanganate, $K_2Mn_2O_8$.
" ferrocyanide, K_4FeCy_6.
" ferridcyanide, $K_6Fe_2Cy_{12}$.
" bitartrate, $KH\overline{T}$.
" and sodium tartrate, $KNa\overline{T}$.
" and antimony tartrate, $KSbOC_4H_4O_6$.
Lead carbonate, $PbCO_3$.
" acetate, $Pb(C_2H_3O_2)_2$.
Starch, $C_6H_{10}O_5$.
Gum, $C_{12}H_{22}O_{11}$.
Cane sugar, $C_{12}H_{22}O_{11}$.
Grape sugar, $C_6H_{12}O_6$.
Alcohol, C_2H_6O.
Aldehyde, C_2H_4O.
Lactic acid, $C_3H_6O_3$.
Cyanogen, CN.
Urea, CN_2H_4O.
Uric acid, $C_5N_4H_4O_3$.
Chloroform, $CHCl_3$.
Chloral, C_2HCl_3O.
" hydrate, $C_2HCl_3O.H_2O$.

CHAPTER II.

NON-METALLIC ELEMENTS, OR "METALLOIDS."

NON-METALLIC ELEMENTS.

Oxygen. Symbol, O. Eq. 8, old system; new, 16. Sp. gr. 1.1057.

OXYGEN is by far the most important of the chemical elements. It unites with all the other elements except fluorine, forming all varieties of compounds. It constitutes one-fifth by weight of the atmosphere, eight-ninths of water, and enters largely into the composition of mineral substances.

It was discovered in 1774 by Scheele in Sweden, and by Priestley in England. Lavoisier, the great French chemist, gave it its name from ὀξύς, acid, and γεννάω, to generate, because it frequently forms acids with positive elements.

Preparation.—It is prepared in a variety of ways, by decomposing oxides.

1. By heating red oxide of mercury (mercuric oxide, or red precipitate) $HgO = Hg + O$.

2. By heating chlorate of potash (potassium chlorate), $KO,ClO_5 = KCl + 6O$; according to the new notation, $KClO_3 = KCl + O_3$.

It is advisable to mix the chlorate with an equal part of the black oxide of manganese, which causes the chlorate to be decomposed at a low heat, while it remains unchanged. Sesquioxide of iron may be used instead of the manganese, in the proportion of 1 part to 10 parts of the chlorate. When prepared from potassium chlorate the oxygen generally contains chlorine.

3. On a large scale, it is made by decomposing MnO_2 by a red heat. Aqueous vapor and carbonic acid are first given off and then oxygen. $3MnO_2 = Mn_3O_4 + 2O$.

4. By the decomposition of peroxide of barium (barium dioxide). The peroxide is made by passing air freed from CO_2 over baryta heated to low redness, and when it is heated to a full red heat, it gives off the oxygen it previously absorbed. In this process, the gas is obtained from the atmosphere; and the oxide of barium may be employed repeatedly.

There are various other methods, as by decomposing sulphuric acid, nitre, red lead, and by heating plaster of Paris and sand; but the above are the most important.

Properties.—Pure oxygen is an insipid, colorless, and inodorous gas, permanently elastic under all temperatures and pressures, and perfectly neutral to test paper. At 60° F. and 30 in. bar. its specific gravity is 1.1057, one hundred inches weighing 34.29 grains. It is the least refractive, but the most magnetic of all

gases, its magnetic force, compared with air, being as 17.5 to 3.4. Specific heat, compared with air as unity, is for equal volumes .9765, for equal weights .7747. It is a bad absorber and radiator of heat. Water at 60° dissolves 3 per cent. of its volume of oxygen. This dissolved gas enables fishes, etc., to live under water.

It is the great supporter of combustion; which takes place in pure oxygen with much greater brilliancy than in the atmosphere. Most combustible bodies contain carbon and hydrogen, which when burnt give carbonic acid and water. The diamond (pure carbon) may be entirely consumed in oxygen gas. Phosphorus lighted and introduced into a jar of it, burns with dazzling brightness and intense heat, producing phosphoric acid (phosphoric oxide). Sulphur burns with a brilliant blue flame, giving SO_2; potassium KO_3 (K_2O); Sodium Na_2O_3 (Na_2O), and iron Fe_3O_4.

Respiration, a species of combustion, depends entirely upon the action of oxygen of the air on the venous blood, which is oxidized into arterial. The effete C and H are burnt up, and thus the bodily heat is sustained.

Oxygen is the most important but not the only acidifying principle. It forms what are called the oxy-acids. If a metal combine in several proportions with this element, the compounds possess basic or acid properties according to the quantity of O they contain; thus, manganese makes with oxygen the following substances:—

MnO protoxide of manganese, a strong base (manganese monoxide).

Mn_2O_3 sesquioxide of manganese, a weaker base.

MnO_2 deutoxide of manganese, a neutral body.

Mn_3O_4 red oxide of manganese.

MnO_3 manganic acid.

Mn_2O_7 permanganic acid; but these acids are not isolable.

Oxygen unites with metals to form alkalies and bases as well as acids, and enters largely into almost all native mineral, animal, and vegetable matters.

The tendency of metallic oxides to unite with acids to produce salts, is much influenced by the degree of oxidation. The protoxide presents the strongest basic properties, and forms the largest variety of saline compounds. If a suboxide is acted on by an acid, an atom of metal is generally set free; if a peroxide, an atom of oxygen.

Sesquioxides may combine with acids, but they need three equivalents of acid for a true sesqui-salt, protoxides requiring but one.

Oxides with three atoms of oxygen to four of a metal, are considered to be compounds of two oxides, one acting as a base and the other as an acid. $Fe_3O_4 = FeO,Fe_2O_3$. $Pb_3O_4 = 2PbO,PbO_2$.

Some metals have no basic or neutral compounds with oxygen, but only acids. Arsenic forms AsO_3, arsenious, AsO_5 arsenic acid. Antimony forms a teroxide (old system) SbO_3 and antimonic acid, SbO_5, which, united together, give antimonious acid, $SbO_3,SbO_5 = Sb_2O_7$.

These compounds are, under the new system, regarded as Sb_2O_3, antimonious oxide; Sb_2O_5, antimonic oxide; and antimony teroxide, Sb_2O_3,Sb_2O_5, this last being sometimes called antimonoso-anti-

monic oxide. *Reduction* or *deoxidation* is the freeing from oxygen of substances which contain it. A metal thus derived from its oxide is called regulus. The true reduction is also applied to the separation of metals from their sulphides, chlorides, etc.

Oxygen is the agent which causes the decay and putrefaction of animal and vegetable substances. Liebig terms the slow oxidation of vegetable matter eremacausis (ἠρέμα slow, and καῦσις burning). Sawdust, cotton, flax, tow, etc., damp and exposed to the atmosphere are subject to slow oxidation. Gutta percha also becomes altered from absorption of oxygen.

In some of its combinations it is employed as a deodorizer and disinfectant.

Tests.—Oxygen, when uncombined, may be recognized by—

1. Rekindling into a flame an ignited match, nearly extinguished.
2. Its entire solubility in a mixture of potassa and pyrogallic acid.
3. Producing orange-colored, acid fumes with NO_2 (N_2O_2).
4. Changing white ferrocyanide of iron to Prussian blue.

The quantity of O in a mixture of gases may be determined by combustion with H, or by its absorption, as in the second test above.

Combustion is the result of the intense chemical combination between two or more bodies, attended with the evolution of light and heat. In all ordinary cases, oxygen is the *supporter of combustion*, and the intensity of the action is dependent upon the rapidity of oxidation as well as upon the quantity of oxygen consumed, the heat being due to the amount of O consumed. In no case is there any loss of matter, but merely a change of state, the products of combustion being always equal in weight to the combining bodies.

Ignition or *incandescence* is the term used when the body giving out the light, does so, not from combining with another, but merely from being itself highly heated. Gases and vapors as well as solids may be rendered incandescent.

Bromine, chlorine, sulphur, etc., give rise to the phenomena of combustion with some other bodies, and are hence called supporters of combustion. *Flame* is the result of the combustion of volatile or gaseous matters. It is hollow, because the vapor cannot burn except when it comes in contact with the oxygen. The *luminosity* of flame is due to the presence of minute solid particles, not consumed. For combustion it is not necessary that the O be gaseous. Strong combustibles mixed with salts containing much O burn, as in gunpowder. Two solids thus uniting without, however, exploding, are said to *deflagrate*.

OZONE.—Ozone (from ὄζω, to smell) is an allotropic modification of oxygen; and antozone is another. Ozone is sometimes represented by $+$ O, and antozone $-$O.

Preparation.—Ozone $\ddot{O}$ may be procured by exposing phosphorus, partly covered with water, to the action of the atmosphere in a stoppered bottle; by the slow combustion of ether by means of a hot glass rod, etc., by a mixture of permanganate of

potassa and sulphuric acid. It cannot be obtained except largely diluted with air.

Properties.—Ozone is insoluble in water, alcohol, or ether, but is dissolved by a solution of an alkaline iodide, producing an iodate. It decomposes proto-salts of manganese with the formation of the peroxide.

In its chemical action it resembles chlorine. It is a powerful oxidizer, bleaching vegetable colors. It destroys caoutchouc and cork. It acts as a disinfectant, destroying the effluvia by oxidation; hence, its great value in the atmosphere. Localities where ozone is found are much healthier than others in which it cannot be detected.

It is a constituent of the alkaline permanganates, which accounts for their decomposition by organic matter.

Compounds containing oxygen as ozone, are called *ozonides*, as Mn_2O_7. Antozone is supposed to exist in certain peroxides. An ozonide, with peroxide of iron, produces a series of purple colors with strychnia, an antozonide does not. Ozone and antozone neutralize each other, giving rise to simple oxygen.

Ozone is much denser than ordinary oxygen, and is destroyed by a heat of 140°, by contact with olefiant gas, by phosphorus, or reduced silver, etc. etc.

The *test* is paper moistened with a solution of iodide of potassium and starch; if O be present, the iodide is decomposed and a blue color produced. The proto-salts of manganese are also similarly used, giving a brown precipitate with ozone.

Hydrogen. Symbol, H. Eq. 1. Comb. vol. 1. Sp. gr. .0695.

Hydrogen was first examined by Cavendish in 1766. The name is derived from ὕδορ, water, and γεννάω, to produce. It forms one-ninth by weight of water, and enters largely into animal and vegetable compounds. It is not found in nature in a free state.

Preparation.—It is generally obtained by the decomposition of water.

1. By the action of dilute sulphuric acid on zinc, etc. According to the old notation, $Zn + HO,SO_3 = ZnO,SO_3 + H$; or

$$\text{Eq. 49 parts sulphuric acid} = \begin{cases} H & \text{———} \quad H\ 1\ \text{part.} \\ O & \\ SO_3 & \end{cases}$$
$$\text{32.52 zinc} \quad . \quad . \quad . \quad . \quad = Zn \text{ ———} \quad ZnO,SO_3\ 80.52\ \text{parts.}$$

Under the new system, it is stated that, in this reaction, a *hydrogen* sulphate is converted into a *zinc* sulphate, by the substitution of zinc for hydrogen; the latter gas being given off: $SO_4H_2 + Zn = SO_4Zn + H_2$. One cubic inch of water contains 28 grs. or 1350 cubic inches of H. Prepared by this method it is liable to contain arsenic and sulphur.

2. By passing steam over red-hot iron fillings, etc.

3. By decomposing water by K, Na, etc. When potassium is thrown upon water it takes fire, burning with a purple flame.

4. By the electric decomposition of water.

Properties.—Hydrogen is a permanently elastic gas without taste, smell, or color, but only slightly soluble in water. It may be

breathed with safety provided O is present, but gives a squeaky tone to the voice.

It is the lighest gas known ; 100 cub. in., at 60° F., and 30 inches of the barometer, weighing only 2.14 grains. It is strongly electro-positive ; hence some chemists have supposed it to be metallic. It is combustible, but not a supporter of combustion. It burns with a colorless flame, forming water. Mixed with three times its volume of air it explodes on the application of flame. With oxygen in the proportion of two volumes of H to one of O, the explosion is very violent. This is due to the great condensation and the consequent rush of air, water being produced, and gases condensing to about $\frac{1}{2000}$th of the original volume. When slowly consumed in a jet, it gives but little light but great heat, as the light is due to extraneous solid matter in the flame, and rendered incandescent by the heat. When a tube with a large diameter is held over a burning jet of hydrogen, a musical note is produced, varying with the dimensions of the tube. When H and O are burnt together in a jet in the proportions proper to form water, there is produced an intense heat capable of fusing rock-crystal, and clay. This is the principle of the *oxy-hydrogen blowpipe*. Platinum, asbestos, lime, etc., introduced into the flame, become intensely incandescent. In the *Drummond light*, a constantly revolving cylinder of lime is placed in the jet of gas, giving a light which can be seen one hundred miles.

When a jet of hydrogen is forced upon a piece of spongy platinum, the metal rapidly becomes heated. and finally the gas is ignited. This is due to the condensation of the H in the pores of the metal, and the consequent closer contact with O results in the combustion of the gas.

The compounds of hydrogen are sometimes called hydrides. Of the metals, there are a few such compounds ; but of carbon, a great number.

Tests.—1. Its combustion producing water only. 2. Its lightness. 3. Its insolubility.

Compounds.

Of H and O there are two combinations ; water, on the old system HO, and the binoxide HO_2 ; according to the new notation these are, H_2O (or OH_2), and H_2O_2 (or O_2H_2) ; the recent name for the latter being *hydrogen dioxide.*

Water.—It is a clear, colorless, tasteless, and inodorous liquid. Its composition was first demonstrated by Cavendish and Watt in 1781. It is a neutral oxide of hydrogen, and consists by weight of eight parts of O and one of H, or by measure of one of O and two of hydrogen, condensed into two volumes of steam.

At a temperature of 212° and mean pressure, the volume of steam is 1689 times that of an equivalent amount of water ; or, in round numbers, a cubic inch of water makes a cubic foot of steam.

Water is never met with in nature perfectly pure. It always contains air. The purest form is rain water, then spring, river, sea, and, finally, the most impure, marsh water. Sea water has a specific gravity of 1.027.

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The following analysis of sea water will show its usual impurities :—

	From the British Channel.	Mediterranean.
Water	963.74372	962.345
Chloride of sodium	28.05948	29.424
" potassium	0.76552	0.505
" magnesium	3.66658	3.219
Bromide "	0.02929	0.556
Sulphate of magnesia	2.29578	2.477
" calcium	1.40662	1.357
Carbonate "	0.03301	0.114
Iodine	traces	
Ammonia	traces	
Oxide of iron		0.003
	1000.00000	1000.000
Sp. gr.	1027.4 C. 60° F.	1025.8 C. 70° F.

Below 32° F. water freezes (crystallizes) in crystals of the sixth system, forming ice, the density of which is .94. It evaporates at all temperatures, even below 32°, and at 212° it boils. It is the standard of specific gravities; a cubic inch at 60° F. and 30 in. barometer, weighs 252.456 grains. The point of greatest density is not, as we might suppose, at the freezing point, but at 39.2°. It is the most extensive solvent known. In its chemical relations it is perfectly neutral. It unites with both acids and alkalies, but can generally be driven off by heat. Hydrate of potassa, however, resists all attempts to decompose it by heat.

Compounds into which water enters are called *hydrates.* Bodies which contain no water are called *anhydrous.* Many salts unite with water, which is necessary to their crystallization—hence called *water of crystallization.* The form of the crystals often depends upon the amount of water of crystallization present. Some salts lose their water by simple exposure to the atmosphere, and crumble into powder—hence they are said to effloresce; others absorb water from the atmosphere, and are said to deliquesce.

When water is united to a strong base it acts as an acid (acid water); when combined with a strong acid it acts as a base (basic water).

BIN OR DEUTOXIDE OF HYDROGEN, *hydrogen dioxide,* or *oxygenated water.* Discovered by Thenard in 1818.

Preparation.—BaO heated to dull redness in oxygen becomes BaO_2; which moistened forms $BaO_2,6HO$. This hydrate is acted on by hydrochloric acid in cold water; a chloride of barium is formed, the excess of oxygen uniting with a portion of the water producing the peroxide. The chloride of barium is then removed by precipitation.

Properties.—It is a colorless, syrupy liquid, possessed of bleaching properties. It is very unstable—sp. gr. 1.453.

Nitrogen. Symbol, N. Eq. 14. Sp. gr. .9713.

Nitrogen (from νίτρον, nitre, and γεννάω, to produce) was discovered by Dr. Rutherford in 1772. It was called azote by Lavoisier (from α priv., and ζωή, life). It forms four-fifths by weight of

the atmosphere, and enters largely into the composition of many organic substances.

Preparation.—It is generally obtained by removing the oxygen from the air, leaving the nitrogen. This may be done by burning phosphorus in a close vessel, and then absorbing the phosphoric acid formed, by water. The O may also be got rid of by means of moistened iron filings; by copper turnings and hydrochloric acid vapor; by a solution of pyrogallic acid and potassa; by passing the air over metallic copper heated red-hot; by ammonia and chlorine, $NH_3 + 3Cl = 3HCl + N$; by heating nitrate of ammonium; or heating nitrite of potassium and sal ammoniac.

Properties.—The distinguishing character of nitrogen is its having only inert properties. It is a permanently elastic, neutral gas, without smell, taste, or color. Water dissolves one and a half per cent. of its volume of the gas. It will not combine with oxygen, except under peculiar circumstances, such as being subjected with O to the electric spark, or being burnt in a jet with hydrogen.

Tests.—Its inertness and the instability of its compounds. In organic compounds, by the formation of ammonia or cyanogen in decomposition.

The Atmosphere.

The atmosphere extends about forty-five miles (some physicists believe much further) above the surface of the earth. It is the standard of specific gravity, etc., for gases, and is 815 times lighter than water—100 cubic inches weighing about 31 grs.

It is a mixture of oxygen and nitrogen in the general proportion of four-fifths by weight of the latter to one-fifth of the former, but it always contains small quantities of other gases and vapors, which vary with the locality.

Average composition of the atmosphere:—

Oxygen	20.61
Nitrogen	77.95
Carbonic acid	.04
Aqueous vapor	1.40
Nitric acid, Ammonia, Carburetted hydrogen,	traces.
In cities and towns there are found—	
Sulphuretted hydrogen	traces.
Sulphurous acid, etc.	traces.

Air is a mixture, not a compound. Hence the proportions of its constituent gases vary slightly in different locations. The O and H are differently absorbed by water. Its active properties are all due to oxygen, the nitrogen serving merely as a diluent. The proportion of carbonic acid varies from 3.7 to 6.2 parts in 10,000 volumes, except where it is increased in confined places by respiration or combustion.

The quantity of moisture in the air is very variable, and is detected by instruments called *hygrometers*, which are either chemical, absorption, or condensation hygrometers or psychrometers. The *dew-point* is the temperature at which moisture is deposited from the air. In India it has been known to be 61° below the temperature of the surrounding atmosphere.

The pressure of the atmosphere is equal, at 30 in. barometer, which is taken as the mean, to 14.6 lbs. to the square inch. The pressure diminishes in a geometrical ratio, as the altitude above the level of the sea increases in an arithmetical progression; thus at 2.705 miles the volume of air becomes two volumes, at 5.410 miles it becomes four, and so on. In the lower strata of air the temperature decreases 1° for every 352 feet of altitude.

Analysis of the air is effected in numerous ways—generally, by removing the oxygen, by combining it with a foreign substance, as by absorbing it with an alkaline solution of pyrogallic acid, or by combination with hydrogen in an *eudiometer*. This is a stout graduated glass tube, generally made U shape, in one end of which two platinum wires are soldered, so that their points nearly meet. The air is then introduced at the other end of the tube and measured, a known amount of hydrogen also being inserted. The mixture is then exploded by electric sparks. One-third of the resulting diminution of volume is due to the oxygen present.

Compounds of nitrogen and oxygen are—old notation—

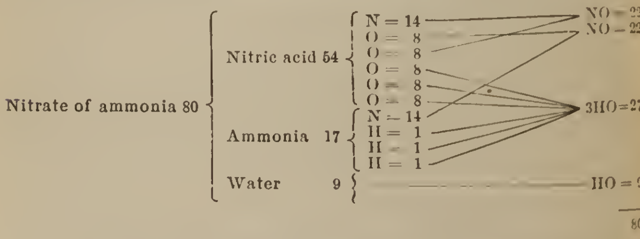
NO = protoxide, nitrous oxide.
NO_2 = deutoxide, nitric oxide.
NO_3 = nitrous acid.
NO_4 = hyponitric acid.
NO_5 = nitric acid.

By the new notation, these are—

N_2O = nitrogen monoxide.
N_2O_2 or NO = nitrogen dioxide.
N_2O_3 = nitrogen trioxide.
N_2O_4 or NO_2 = nitrogen tetroxide.
N_2O_5 = nitrogen pentoxide.

Protoxide, or *monoxide*, *nitrous oxide*, *laughing gas*, was discovered by Priestley, in 1776—was fully investigated by Sir Humphry Davy, in 1800.

Preparation.—By action of nitric acid on zinc or tin, by heating nitric acid with a solution of NH_4Cl, but generally by heating to not exceeding 400° crystals of nitrate of ammonium. The old statement was as follows:—



According to the new method, the formula for the above will be, $NH_4NO_3 = 2H_2O + N_2O$.

One ounce of nitrate of ammonium gives 500 inches or nearly two gallons of the gas, which should be collected over hot water, being largely absorbed by cold.

Properties.—Nitrous oxide is a transparent, colorless gas with a sweetish taste and smell. Sp. gr. 1.527. One hundred measures of water at 32° absorb 130 measures of the gas. The solubility decreases greatly when the temperature rises. It is liquefiable by a pressure of 50 atmospheres at 45° F. The specific gravity of the liquid is .907. By means of liquid nitrous oxide and bisulphide of carbon, a cold of —220° has been obtained.

Many substances may be made to burn in this gas, the combustion being but little less brilliant than that in oxygen itself. It supports for a time respiration, and produces, when breathed, a species of intoxication, which is, however, not usually followed by any bad effects. It should not be used by plethoric persons. Recently, it has been employed as an anæsthetic in surgery.

It is composed of 14 parts of nitrogen and 8 of oxygen—or by volume—1 measure of oxygen with two of nitrogen, condensed into two volumes.

Tests.—Its power of supporting combustion, being distinguished from O by its absorption in water and by its negative action on NO_2.

DEUTOXIDE, *nitric oxide, nitrogen dioxide.*

Preparation.—By the action of moderately dilute nitric acid on copper turnings and collecting over water. At first, copious fumes are given off on account of the presence of air. These fumes are absorbed by the water, and finally colorless nitric oxide is evolved.

$$\text{(Old formula)}\ 4NO_5 + 3Cu = (CuO,NO_5) + NO_2.$$
$$\text{(New)}\ 8NO_3H + Cu_3 = N_2O_2 + 3(NO_3)_2Cu + 4H_2O.$$

It is also formed by the action of protochloride of iron on aqua regia.

Properties.—It is a colorless, permanently elastic gas. Specific gravity 1.0365. Produces with oxygen orange-colored fumes, but very sparingly soluble in water. It is not a supporter of combustion, but potassium and a few other bodies will burn in it.

Tests.—The red fumes with oxygen, and its entire solubility in a solution of a protosalt of iron, forming a black compound.

NITROUS ACID, formerly called hyponitrous acid; *nitrogen trioxide.*

Preparation.—By mixing four volumes of nitric oxide with one volume of oxygen, or by heating one part of starch with eight parts of nitric acid.

Properties.—It is a bluish liquid, very volatile, giving off reddish-yellow fumes. It is decomposed, by contact with water, into nitric acid and nitric oxide. Its salts cannot be made by direct combination, but are generally procured by heating the corresponding nitrates.

HYPONITRIC ACID, formerly called *nitrous acid; nitrogen tetroxide.*

Preparation.—By uniting two volumes of nitric oxide and one of oxygen; by distilling nitrate of lead.

Properties.—It is a liquid. Sp. gr. 1.45. Its color varies with the temperature from a pale yellow to a deep orange. It is very volatile, giving off orange-colored fumes. Water decomposes it.

It is distinguished from nitrous acid by giving a red color to a solution of sulpho-cyanide of potassium.

NITRIC ACID. *Azotic Acid. Aqua Fortis. Nitrogen Pentoxide.* Its composition was first shown by Cavendish in 1785, by the action of an electric spark in a mixture of O and N.

Anhydrous nitric acid, *nitric anhydride*, was discovered by Deville, in 1849, by passing chlorine over nitrate of silver. It is perfectly inert until hydrated. The crystals melt at 85°.

Preparation.—Hydrated nitric acid, *hydrogen nitrate*, is obtained by distilling nitrate of potassium or sodium with sulphuric acid. This gives an acid of specific gravity 1.4; the most concentrated is 1.52. It is generally a fuming red acid, from the hyponitric acid present.

Properties.—The strongest acid boils at 184° and freezes at —40°. The next hydrate contains four equivalents of water, and is intense in its action. It is a powerful oxidizer, destroying animal substances and oxidizing the metals upon which it acts in several ways. In the reaction with zinc, etc., ammonia is formed.

Nitric acid is monobasic, and many of its salts are anhydrous. It is sometimes used in fumigations required by contagious diseases, instead of chlorine.

Tests.—It may be detected (1) by heating a previously neutralized and evaporated solution with sulphuric acid and copper turnings, when, if nitric acid be present, red fumes will be liberated; (2) by producing a brown liquid with a solution of a protosalt of iron; and (3) by its bleaching a solution of sulphate of indigo.

Nitrogen and Hydrogen.

The compounds of these two elements are :—

Amidogen,	NH_2	hypothetical.
Ammonia,	NH_3	
Ammonium,	NH_4	hypothetical.

AMIDOGEN (NH_2).—This is supposed to exist in certain organic compounds, and in some combinations with the metals. When K or Na is heated in dry ammonia, a greenish substance is formed, KNH_2, which, with water, gives $KO(K_2O)+NH_3$. It exists also in white precipitate. Its compounds are called *amides*.

AMMONIA (NH_3). *Volatile Alkali.*

Preparation.—It may be obtained by heating equal parts of quicklime and sal ammoniac. On the old system, the formula for this reaction is, $CaO+NH_4Cl=CaCl+HO+NH_3$. According to the new method, $2NH_4Cl+CaO=2NH_3+CaCl_2+H_2O$. It is formed in small quantities when electric sparks are passed through a mixture of nitrogen and hydrogen; also when iron rusts in water containing air; when nitric acid acts on zinc, tin, etc., and when animal substances containing nitrogen decompose.

Properties.—It is a colorless gas with a pungent and suffocating odor, irrespirable, except when diluted with air, when it is an agreeable stimulant. It does not support combustion, but is itself slightly combustible. Sp. gr. .59. It can be liquefied by a cold of —40°, or at a temperature of 40° by a pressure of 6.5 atmospheres. This liquid is most readily obtained by disengaging it by

heat, in a sealed tube, from chloride of silver which has been previously saturated with the gas. It is a colorless liquid, sp. gr. .76, solid at —103°.

Water at a temperature of 50° absorbs 670 times its volume of the gas, the bulk of the water being thereby increased one-third, and its sp. gr. of course diminished, that of the saturated solution being .875. It freezes at —40°.

Ammonia is generally found in solution, when it is often called *spirits of hartshorn.* The ordinary solutions are—

Saturated, sp. gr.	.875,	containing	32.3	per cent.	of gas.
Common, "	.889	"	26	"	"
P. L., "	.96	"	10	"	"

Ammonia has all the chemical properties of an alkali. Diffused in the air its N is liable to be oxidized by ozone, hence the presence of alkaline nitrates in places where putrefaction has been going on.

It is composed of two volumes of N with three of H condensed into four volumes.

Tests.—Its odor, volatility, and alkaline reactions, and by its producing white fumes with HCl.

Ammonium (NH_4) and its salts will be described under the head of Metals.

Chlorine. Symb. Cl. Eq. 35.5. Sp. gr. 2.4876.

The *halogen bodies* is a term used to denote those non-metallic elements which, uniting directly with the metals, form compounds analogous to common salt, NaCl. They are chlorine, iodine, bromine, and fluorine. Cyanogen, although not elementary, is, on account of its chemical similarity, generally included in this list.

Chlorine was discovered by Scheele in 1774. It was supposed to be a compound of oxygen and muriatic acid, until its true character was demonstrated by Davy, in 1810.

Preparation.—It is procured most conveniently by heating chlorohydric acid with MnO_2. $2HCl + MnO_2 = Cl + MnCl + 2HO$; or (new notation) $MnO_2 + 4HCl = Cl_2 + MnCl_2 + 2H_2O$.

Properties.—It has a greenish-yellow color (whence its name) and excites great irritation of the lungs even when dilute. It is liquefied by a cold of —106°, or by a pressure of four atmospheres at 60°. It combines with aqueous vapor to form a crystalline hydrate. It is soluble in one-half its bulk of cold water. On account of its powerful attraction for hydrogen, it is a powerful disinfectant and bleacher, for which purposes it is generally employed in the form of chloride of lime. Chlorine is not combustible. Many substances containing hydrogen burn in it, owing to the violent combustion of the H and Cl, while if any carbon is present it is deposited in the form of a dense smoke. Phosphorus and some metals, as copper, antimony, and arsenic, take fire spontaneously when introduced into this gas.

It combines with all the metals. The resulting chlorides, with the exceptions of chloride of silver and the sub-chlorides of copper and mercury, are soluble in water. Its strongest affinity is for hydrogen, which it removes even from oxygen.

Tests.—When uncombined, its color, odor, and bleaching qualities. When combined, its forming with nitrate of silver a curdy white precipitate, soluble in ammonia.

Compounds of Chlorine and Oxygen.

These elements do not unite directly, and when united are easily separated. Their compounds are (old notation)—

Hypochlorous acid	ClO.
Chlorous acid	ClO_3.
Peroxide of chlorine	ClO_4.
Chloric acid	ClO_5.
Perchloric acid	ClO_7.

According to the new chemistry, the acid compounds of chlorine and oxygen are regarded as *oxides of hydrochloric acid;* thus—

Hypochlorous acid	$ClHO$.
Chlorous acid	$ClHO_2$.
Chloric acid	$ClHO_3$.
Perchloric acid	$ClHO_4$.

Three *anhydrous chlorine oxides* also exist, the first two of which correspond to hypochlorous and chlorous acids—

Hypochlorous oxide	Cl_2O.
Chlorous oxide	Cl_2O_3.
Chlorine tetroxide	Cl_2O_4.

HYPOCHLOROUS ACID is formed by agitating chlorine with red oxide of mercury and water. Its salts are all made by passing chlorine through a solution of the base.

It is a yellowish, strongly odorous gas, soluble in about $\frac{1}{200}$ of its bulk of water; is a powerful oxidizing agent, and very unstable. Sp. gr. 3.04.

CHLOROUS ACID is obtained by distilling arsenious acid, chlorate of potassium, nitric acid, and water. The arsenious acid is first oxidized by the nitric acid, which is then reformed by the chloric acid.

It is a greenish-yellow gas, soluble in one-fifth its bulk of water. Is a powerful bleaching agent, and is easily decomposed. It is distinguished from hypochlorous acid by adding arsenious acid dissolved in nitric acid, which destroys the bleaching powers of the hypochlorites but not of the chlorites. Sp. gr. 2.646.

PEROXIDE OF CHLORINE (*chlorine tetroxide*) is formed by the action of sulphuric acid on fused chlorate of potassium.

It is a powerful oxidizing gas of a dark yellow color, and is easily liquefied. Sp. gr. 2.33.

CHLORIC ACID is procured by decomposing chlorate of barium by sulphuric acid or by the action of hydrofluosilicic acid on chlorate of potassium. Its salts are made by passing chlorine through a solution of the base. The two resulting salts are separated by crystallization.

Chloric acid cannot be obtained anhydrous. The hydrated acid is a yellowish tinted liquid of powerful oxidizing qualities. In its chemical relations it strongly resembles nitric acid.

The chlorates are all soluble in water, and give off oxygen when heated, becoming chlorides.

Tests.—Odor of peroxide of chlorine when sulphuric acid is added, bleaching solution of indigo in sulphuric acid in the cold, which nitric affects only by the aid of heat.

Perchloric Acid.—The potassium salt of this acid is obtained by stopping the decomposition of chlorate of potassium when about one-third only of the oxygen has been expelled.

This acid is formed in the preparation of peroxide of chlorine. Its salts are all soluble in water.

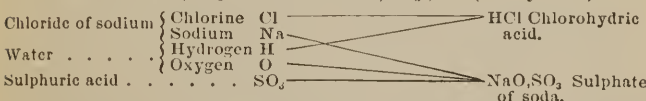
Chlorine and Hydrogen.

The only compound of these elements is chlorohydric acid.

Chlorohydric, *hydrochloric, or muriatic acid. Spirits of salt* (HCl).—This acid was discovered by Priestley in 1772.

Preparation.—When Cl and H are mixed in equal volumes and exposed to a flame or to sunlight, they combine with explosion. But this acid is generally obtained by distilling one part of common salt (NaCl) with two of sulphuric acid—

$$NaCl + HO,SO_3 = HCl + NaO,SO_3 \text{ ; or (old system)}$$



According to the new method, this *rationale* may be expressed as follows: $2NaCl$ (sodium chloride) $+ SO_4H_2$ (hydrogen sulphate $= 2HCl$ (hydrochloric acid or hydrogen chloride) $+ SO_4Na_2$ (sodium sulphate).

Properties.—It is a colorless, irrespirable gas, sp. gr. 1.269. By a pressure of 40 atmospheres at 50°, it is condensed into a liquid. Water absorbs 480 to 500 times its bulk of the gas, forming the ordinary liquid chlorohydric acid, or spirits of salt. The gas is passed through water contained in a series of *Wolfe's* bottles, and is thus absorbed. The most concentrated solution has a sp. gr. of 1.21.

In its action upon metallic oxides the hydrogen of the acid combines with the oxygen of the oxide forming water, while the chlorine unites with the metal.

Tests.—Dense white fumes, NH_4Cl, in the presence of ammonia. White curdy precipitate with nitrate of silver, soluble in ammonia but not in nitric acid.

Nitro-chlorohydric Acid, *Aqua Regia.*—When NO_5 and HCl are mixed, the mixture will, by means of the nascent chlorine evolved, dissolve gold and platinum, which are unattacked by any single acid. Hence its name of aqua regia. The best proportions are, one of nitric acid to three of chlorohydric acid.

By the distillization of aqua regia, *chloro-nitric acid*, NO_2Cl_2, and *chloro-nitrous acid*, NO_2Cl, are obtained.

Chlorine and Nitrogen.

CHLORIDE OF NITROGEN (NCl_3).—A fearfully explosive substance, thus called, formed by the action of Cl on sal ammoniac (NH_4Cl) or nitrate of ammonium, was discovered by Dulong in 1812. It is worthy of being remarked, that the light and heat evolved by its explosion are inexplicable by ordinary theories, which always suppose light and heat to be produced by combination alone.

Bromine. Symbol, Br. Eq. 80. Sp. gr. 2.96.

Bromine (from βρῶμος, a stench) was discovered by M. Balard in 1826 in *bittern* or the residue of sea water.

Preparation.—It is obtained by passing chlorine through bittern, and then separating it by agitating with ether, which dissolves it. Its purification is accomplished by combining it with potassa, and distilling with sulphuric acid and peroxide of manganese.

Properties.—It is a deep red liquid, giving off brownish-red vapor, boils at 145°, and is solid at 10.4. It is slightly soluble in water.

Test.—It turns starch yellow.

Bromine and Oxygen.

BROMIC ACID (BrO_5, old method; new, BrO_3H).—This is the only known compound of bromine and oxygen.

Preparation.—It is procured by acting on caustic potassa with bromine, a process similar to that for chloric acid.

From this bromide of potassium, bromide of barium is obtained by double decomposition, and this is then decomposed by sulphuric acid, when the bromic acid, a colorless, inodorous liquid, is set free.

Hydrogen and Bromine.

These elements form an acid corresponding to hydrochloric acid.

BROMOHYDRIC ACID (HBr.).—Above 100° this acid is gaseous. It is colorless and inflammable; obtained by the action of phosphoric acid on bromide of potassium.

Iodine. Symbol, I. Eq. 127. Sp. gr. 4.946.

Iodine (from ἰώδης, violet-colored) was discovered in 1812 by Courtois. It is found in sea-weed, sponges, and a few minerals.

Preparation.—It is procured by heating *kelp* (ashes of sea-weeds) with binoxide of manganese and sulphuric acid. Old formula—

$$NaI + MnO_2 + 2(HO,SO_3) = NaO,SO_3 + MnO,SO_3 + 2HO + I.$$

The new formula for this reaction is this:—

$$2KI + MnO_2 + 2SO_4H_2 = I_2 + SO_4K_2 + SO_4Mn + 2H_2O.$$

Properties.—It occurs in bluish-black crystals, or scales, like plumbago. It is very volatile, fusing at 225° and boiling at 347°. It gives a beautiful purple vapor, whence its name. It is soluble in 7000 times its weight of pure water, but when iodide of potas-

sium, chloride of ammonium, nitrate of ammonium, or iodohydric acid is present, its solubility is much increased. *Lugol's solution* consists of 30 gr. I, 60 gr. KI, f ℥ij Aq. It is very soluble in alcohol and ether. Taken internally it acts as an irritant poison, but in small doses it is used for glandular swellings, etc.

Test.—It gives an intense blue color with starch. This test is of sufficient delicacy to show the presence of iodine in a liquid containing but one-millionth part of it.

Iodine and Oxygen.

The compounds of these elements are iodic and periodic acid.

IODIC ACID (IO_5, old system ; new, $I_2O_5H_2O$).—This corresponds to chloric, bromic, and nitric acids ; obtained by boiling iodine in nitric acid. Like the chlorates and bromates, its compounds evolve O by heat.

PERIODIC ACID (HO,IO_7, old ; new, $I_2O_7H_2O$).—The periodates are obtained by the action of chlorine on an alkaline iodate.

Hydrogen and Iodine.

IODOHYDRIC, or *Hydriodic Acid* (HI).—It is obtained by the action of iodine and phosphorus on a solution of iodide of potassium.

Properties.—It is a colorless gas, sp. gr. 4.387, freezing at —60°. It is decomposed by a red heat. Like other hydrogen acids, it is very soluble in water, but the solution is unstable.

IODIDE OF NITROGEN (NI_3) is obtained by the action of ammonia on finely-powdered iodine. It is a brown solid, which is dangerously explosive, even under water.

Fluorine. Symbol, F. Eq. 19.

Fluorine exists in fluor spar (whence its name), in plants, in the enamel of teeth, etc.

Properties.—It is supposed to be a gas, but by reason of its intense affinities it cannot be permanently isolated. Its affinity for silicium makes it destructive of glass. It combines with all other elements, except oxygen, carbon, and the halogens. Its theoretical density is 1.313.

Hydrogen and Fluorine.

FLUO-HYDRIC ACID (HF) is prepared by the action of sulphuric acid on fluor spar.

Properties.—It is a colorless liquid, emitting dense fumes in the air, boiling at 68°. Sp. gr. of the vapor, 1.0609. It forms with water a compound. Its affinity for water exceeds that of sulphuric acid. The vapor is dangerously pungent, and the liquid in contact with the skin produces painful sores.

It is much used for etching upon glass, which is covered with wax and exposed to the acid fumes.

Test.—Fl etching on glass.

Sulphur. Symbol, S. Eq. old, 16 ; new, 32. Sp. gr. (various).

The chief sources of sulphur are the volcanic districts of the Mediterranean. Some is procured from Iceland. Pyrites contains

a large proportion. It is found also in albumen, fibrin, and casein, in silk, hair, etc.

Preparation.—It is purified from the native material by successive distillations. When the receiver is kept cool, the sulphur is deposited as a powder, which is called *flowers of sulphur*. When the receiver is hot, it is deposited as a liquid and moulded, forming *roll-sulphur* and *brimstone*. The poorer varieties are obtained from pyrites.

Properties.—As a solid, it is brittle, of a pale yellow color and insipid taste, and inodorous, except when rubbed or heated. It is a non-conductor of heat and electricity, but becomes negatively electrified by heat and friction. It is highly inflammable, taking fire between 450° and 500°, giving pale blue flames and suffocating fumes of sulphurous acid.

There are three allotropic modifications. $S\alpha$, as found native, crystallizing in rhombic octohedra, which is also the form of the crystals deposited from solution. Its density in this state is 2.05, and it fuses at 230.

$S\beta$ obtained by fusion; it crystallizes in oblique rhomboidal prisms—sp. gr. 1.98, the density of roll sulphur, which belongs to this variety. It melts at 248°, and is changed to $S\alpha$.

$S\gamma$. When melted sulphur, between 340° and 480° (viscous state), is poured into water, it forms a soft tenacious mass like gutta-percha, which afterwards hardens, and hence is sometimes used for taking impressions of coins.

When sulphur is heated it undergoes many curious changes, as follows:—

Temperature.	Hot Sulphur.	Suddenly Cooled by Water.
230°	Very liquid, yellow.	Very brittle, usual color.
284°	Liquid, deep yellow.	Do. do.
338°	Thick, orange yellow.	Brittle, do.
374°	Thicker, orange.	At first soft and transparent, then brittle, then opaque, usual color.
428°	Viscid, reddish.	Soft, transparent, amber color.
464° to 500°	Very viscid, brownish-red.	Very soft, transparent reddish.
800 (boiling)	Less viscid, brownish-red.	Do. do. brown.-red.

The sp. gr. of the vapor at 932° is 6.654.

It is not dissolved by alcohol, ether, or chloroform; 100 parts of bisulphide of carbon dissolve, when cold, 38 parts of sulphur, and when hot 73 parts. It is also soluble in the alkaline sulphates, oil of turpentine, and chloride of sulphur. It is variously used—for vulcanizing India-rubber, for matches, gunpowder, etc. Lac sulphuris is sulphur precipitated from tersulphide of potassium or penta-sulphide of calcium by chlorohydric acid, and washed.

Tests.—Black precipitate with acetate of lead; for an alkaline sulphide, a beautiful purple color with nitro-prusside of sodium.

Sulphur and Oxygen.

The compounds of these elements are numerous and important. According to the old system these are:—

SO_2, sulphurous acid.
S_2O_2, hyposulphurous or dithionous acid.
SO_3, sulphuric acid.
S_2O_5, hyposulphuric or dithionic acid.
S_3O_5, monosul-hyposulphuric or trithionic acid.
S_4O_5, bisul-hyposulphuric or tetrathionic acid.
S_5O_5, trisul-hyposulphuric or pentathionic acid.

In the new chemistry the statement is, that there are two oxides of sulphur, which may exist in the anhydrous condition; *sulphurous oxide* or sulphur dioxide, SO_2, and *sulphuric oxide* or sulphur trioxide, SO_3. These uniting with water, form "hydrogen salts" or acids; *sulphurous acid*, SO_2H_2O (or SO_3H_2) and *sulphuric acid*, SO_3H_2O (SO_4H_2).[1] There are also several oxacids of sulphur, which have no corresponding anhydrous oxides: viz.,

Hyposulphurous (Thiosulphuric) acid	$S_2O_3H_2$.
Dithionic acid	$S_2O_6H_2$.
Trithionic acid	$S_3O_6H_2$.
Tetrathionic acid	$S_4O_6H_2$.
Pentathionic acid	$S_5O_6H_2$.

SULPHUROUS ACID, or *Sulphurous Oxide* (SO_2).

This compound is formed when sulphur is burned in the air or oxygen. It is best obtained by heating sulphuric acid with copper or mercury, or by heating black oxide of manganese with sulphur.

Properties.—It is a colorless gas, of a suffocating odor, and some taste. It is irrespirable, producing symptoms of ordinary catarrh. It liquefies at 14°, and solidifies at 105°. Water absorbs fifty times its volume of the gas. Moistened articles exposed to it are bleached; but the color may be restored by an alkali.

When this acid and sulphuretted hydrogen gas are mixed, sulphur is deposited, which may account for the deposition of native sulphur in various places.

Tests.—Odor. Iodic acid and starch give a blue color with SO_2; sulphites decolorize a solution of permanganate of potassium; they also give a white precipitate with nitrate of silver.

SULPHURIC ACID. *Oil of Vitriol.*

Preparation.—It can be obtained by the distillation of sulphate of iron—green vitriol—whence the acid is called oil of vitriol.

The ordinary acid is procured by exposing in a leaden chamber sulphurous oxide (from burning sulphur or iron pyrites) to the vapors arising from heated nitre (nitric acid). The chamber contains water, and steam is constantly forced into it. Dilute sulphuric acid is thus obtained, and when the sp. gr. is 1.2 to 1.3 it is drawn off and evaporated, first in leaden and afterwards in platinum stills, until the sp. gr. equals 1.84, when it is placed in carboys for sale. The reactions are complicated, but the following is the old method of explaining the way in which the acid is produced:—

SO_2 with NO_3 and NO_4 becomes SO_3 and NO_2: thus, $5SO_2 + NO_3NO_4 = 5SO_3 + NO_2$. The NO_2 absorbs oxygen from the

[1] SO_4 is sometimes regarded as a radical, *sulphione.*

atmosphere, becoming $NO_{?}$, and again acts on the SO_2. The new system gives, instead, the following account: nitric acid vapor, in contact with sulphurous oxide vapor, yields oxygen to the latter (in the presence of watery vapor) producing sulphuric acid, and being itself reduced, first to nitrogen tetroxide, and then to nitrogen dioxide. The latter, however, taking oxygen from the air, is again converted into nitrogen tetroxide. The formula is this: $NO_2 + SO_2 + H_2O = NO + SO_4H_2$. Water is necessary to cause the gases to unite in this manner. When the supply of water is insufficient, a white crystalline substance is formed. It is decomposed by water.

When anhydrous sulphate of iron is distilled, there is obtained a very strong, dark-colored acid, called *Nordhausen*, *Saxon*, or *fuming sulphuric acid*. When this acid is distilled, *anhydrous sulphuric acid* or *sulphuric oxide* is obtained.

Properties.—The anhydrous acid is a white crystalline body resembling asbestos, and is liquid above 66°. It has no acid properties. When thrown into water, it hisses from the heat evolved, and forms an ordinary hydrate. When the proper proportions are observed, the results are heat, light, and explosion.

There are four definite hydrates.

1. Nordhausen acid (described above). 2. Oil of vitriol. Sp. gr. 1.84. This freezes at —30°. It is an oily looking, colorless liquid, and intensely caustic, charring organic substances. It is often of a brown color from the organic matter in it. It rapidly absorbs water from the atmosphere, and is, therefore, often used for desiccating gases. It boils at 640°, and may be distilled unchanged.

3. Bihydrate; the density of this is 1.78. At 45° it forms large crystals, hence it is called *glacial sulphuric acid.*

4. Terhydrate. Sp. gr. 1.63.

Sulphuric acid displaces almost all other acids from their combinations. Some metals decompose it, forming SO_2. It is decomposed by boiling with sulphur or carbon. It is the most important acid known, being constantly employed both in the laboratory and manufactories. One hundred thousand tons are annually consumed in Great Britain alone.

Tests.—The best test is a white precipitate with a salt of barium, insoluble in nitric acid. It may also be recognized by reducing the compound to be tested with carbon and adding chlorohydric acid, when sulphuretted hydrogen is evolved.

HYPOSULPHUROUS ACID.—This acid is known only in combination. When its salts are heated with an acid, it is decomposed into sulphur and sulphurous acid.

Its salts are formed by digesting S in a solution of a sulphite; or by passing sulphurous acid through an alkaline sulphide. They are used chiefly in photography for dissolving silver salts.

Tests.—Decomposition by an acid; white precipitate with nitrate of silver or lead, soluble in excess.

Sulphur and Hydrogen.

SULPHYDRIC ACID, *Hydrosulphuric Acid*, *Sulphuretted Hydrogen Gas*, *Hydrogen Monosulphide* (HS, old; H_2S, new).

Preparation.—Sulphur and hydrogen do not ordinarily unite directly, but only when they are brought together in the nascent state, as by the decomposition of many organic substances. Sulphide of iron, heated with dilute sulphuric acid, rapidly evolves this gas. The water present is decomposed; its hydrogen unites with the sulphur of the iron sulphide, making sulphuretted hydrogen; and a sulphate of iron is also produced. Prepared in this way, it generally contains free hydrogen on account of the free iron in the sulphide. It may be obtained pure by heating tersulphide of antimony with HCl.

Properties.—It is a transparent colorless gas, with an odor resembling bad eggs, and when concentrated is extremely poisonous; even one part in six or twelve hundred parts of air is fatal to the lower animals. Nausea, headache, and faintness are produced when the diluted gas is breathed. It is inflammable, but does not support combustion. Its combining volume is 2 and its sp. gr. 1.192. It is liquid at a pressure of seventeen atmospheres at 50°. It is decomposed by chlorine, bromine, and iodine, which combine with the hydrogen; also by alkaline permanganates and hydrated peroxide of iron. Charcoal absorbs it, water dissolves three times its volume of the gas. The solution becomes milky by exposure to the air, from the deposition of sulphur. The solution is found native—in sulphur springs. It is much used, both as a gas and in solution, in analysis, as it forms characteristic sulphides with many metals. It is a feeble acid, and combines not with basic oxides but with sulphides. There is also a "hydrogen disulphide" (S_2H_2) of the new system. It is a yellow, viscid liquid, giving out the odor of sulphuretted hydrogen; it is an unstable compound, not easy of preparation. *Sulphydrate of ammonium*, or sulphide of ammonium (NH_4HS, new notation) is an important reagent in chemical analysis.

Tests.—Odor, by which it may be recognized in 200,000 times its volume of air. Darkening paper moistened with acetate of lead.

Sulphur and Chlorine.

There are two CHLORIDES of sulphur. One is formed by passing chlorine into vapor of sulphur. It is a yellowish liquid, used for vulcanizing caoutchouc. The other chloride is obtained by passing chlorine through the above; or by heating sulphur and carbon together, and then digesting sulphur in the product.

Selenium. Symbol, Se. Eq. 39.75, old; new, 79. Sp. gr. 4.32.

Selenium (from σελήνη, the moon) is found in a limited number of minerals. It was discovered by Berzelius, in 1817, in the residue of a sulphuric acid manufactory. In both its physical and chemical properties it resembles sulphur. When heated it emits an odor like decaying horseradish, by which it may be recognized before the blowpipe. It is found in allotropic modifications like sulphur.

It forms SELENIOUS and SELENIC ACIDS, SELENIURETTED HYDROGEN, and SELENOHYDRIC ACID, which resemble the sulphur compounds.

Tellurium. Symbol, Te. Eq. 64, old; new, 128. Sp. gr. 6.2 to 6.8.

Tellurium (from *tellus*, the earth) resembles the metals in physical, but sulphur and selenium in chemical, properties. It forms TELLUROUS and TELLURIC ACID, and TELLUROHYDRIC ACID.

Phosphorus. Symbol, P. Eq. 31. Sp. gr. 1.82.

Phosphorus (from φῶς, light, and φέρω, to bear) is so named from its property of shining in the dark. It was discovered in 1669 by Brandt, of Hamburg. It is an important element in the animal and mineral kingdoms. It is found also in vegetables.

Preparation.—It was formerly obtained from urine, but now from bones. Bones, calcined and powdered, are treated with dilute sulphuric acid. The result is "superphosphate of lime." This is fused, giving *glass of phosphorus*, which contains phosphoric acid and phosphate of calcium. By distillation with charcoal in an earthen retort, the phosphorus is separated, which is then purified by being melted and passed through leather. This superphosphate, on being heated with charcoal, yields subphosphate of calcium, which is not decomposed, and phosphoric acid; this last, with charcoal, gives the phosphorus. Lastly it is generally melted and cast into sticks.

Properties.—Pure solid phosphorus is tasteless, colorless, and semi-transparent, of a waxy appearance. Generally it has a pale yellow or red color, which is increased by exposure to the light. Exposed to the air, it emits fumes which are luminous in the dark, and a garlic odor is also evolved. It takes fire spontaneously in chlorine. It is insoluble in water, but is dissolved by ether and the hydrocarbons, and especially by bisulphide of carbon. It melts at 110°, and boils at 550°. In air it takes fire, and must hence be kept under water. It burns with an intensely bright light and great heat.

It is much used in making lucifer matches, and causes in the workmen necrosis of the jaws. It is poisonous if swallowed.

Amorphous Phosphorus.—When heated to 450° or 460° in nitrogen or carbonic acid, it is changed into red phosphorus, which differs in many respects from ordinary phosphorus. It takes fire less readily (not under 500°), is odorless, is not poisonous, and is not soluble in bisulphide of carbon. Sp. gr. 1.96 to 2.14. By heating to 570° in closed vessels, it is changed into ordinary P.

There are other varieties—as white, viscous, and black phosphorus.

Tests.—When uncombined, it is recognized by luminosity in the dark and by its odor. It gives a green color to burning hydrogen, and green lines in the spectrum.

Phosphorus and Oxygen.

There are three oxides (old system):—

PO	hypophosphorous acid.
PO_3	phosphorous acid.
PO_5	phosphoric acid.

By the new method, these are—

PO_3H_2	hypophosphorous acid.
P_2O_3	phosphorous oxide.
P_2O_5	phosphoric oxide.

Also,

PO_3H_3	phosphorous acid.
PO_4H_3	phosphoric acid.

HYPOPHOSPHOROUS ACID itself has never been isolated. It is formed by boiling phosphorus with an alkali or alkaline earth.

PHOSPHOROUS ACID, or *phosphorous oxide*, is formed by slow combustion of P, or by burning it in a limited quantity of air, or passing chlorine through melted P in water. It may be obtained in crystals containing water. Formerly called *phosphatic acid.*

PHOSPHORIC ACID is obtained anhydrous (*phosphoric oxide*, or *phosphoric anhydride*) only by burning P; hydrous by the action of dilute nitric acid or phosphorus.

It combines with bases in a very peculiar manner, being (according to the old system) either monobasic, bibasic, or tribasic, the corresponding acid containing one, two, or three equivalents of water:—

HO,PO_5 metaphosphoric (glacial phosphoric acid).
$2HO,PO_5$ pyrophosphoric acid.
$3HO,PO_5$ tribasic or common phosphoric acid.

These acids as well as their salts may be converted into one another by the addition or abstraction of water. They all give characteristic reactions. This water may be replaced in metaphosphoric acid by one equivalent, in pyro- by one or two equivalents, and in the common acid by one, two, or three equivalents of a base, so that the whole list is as follows:—

Test.—White prec. with nitrate of silver, soluble in excess of the phosphate.

Old formulæ:—

NaO,HO,PO_5 bipyrophosphate of soda $2NaO,PO_5$ pyrophosphate of soda	White prec. with AgO,NO_5; not soluble in excess of phosphates.
$NaO,2HO,PO_5$ acid phosphate of soda $2NaO,HO,PO_5$ neutral (ordinary) phosphate of soda $3NaO,PO_5$ sub (basic) phosphate of soda	Yellow prec. with AgO,NO_5.

Two or more bases may exist with one equivalent of acid:—

The reactions with AgO,NO_5 are as follows:—

$NaO,PO_5+AgO,NO_5=AgO,PO_5+NaO,NO_5$.

$2NaO,PO_5+2(AgO,NO_5)=2AgO,PO_5+2(NaO,NO_5)$.

$3NaO,HO,PO_5+3(AgO,NO_5)=3AgO,PO_5+2(NaO,NO_5)+HO,NO_5$.

According to the new chemistry, the three modifications of phosphoric acid are said to be, respectively *monobasic*, *tribasic*, and *tetrabasic.*

They are designated as follows :—

PO_3H, metaphosphoric acid.
PO_4H_3, orthophosphoric acid.
$P_2O_7H_4$, pyrophosphoric acid.

The salts of these acids are converted into each other by the loss or gain of one, two, or three molecules of water or atoms of a metallic base. Pyrophosphates may be regarded as compounds of metaphosphates and orthophosphates : $P_2O_7Na_4 = PO_4Na_3 + PO_3Na$.

Phosphoric acid is a white, deliquescent, solid, very soluble acid. Decomposed by heated charcoal.

Test.—Molybdate of ammonium ; giving a yellow deposit.

Phosphorus and Hydrogen.

There are three compounds of these elements, viz :—

P_2H, solid. PH_2, liquid. PH_3, gas.

PHOSPHORETTED HYDROGEN GAS (PH_3) is prepared by heating P in a strong solution of potassa or milk of lime. It may also be obtained by the action of chlorohydric acid on phosphide of calcium in water.

It is a colorless gas, with a fetid odor. It takes fire spontaneously if vapor of PH_2 be present, which is generally the case when prepared in the laboratory. This may be prevented by the vapor of ether. If the gas be passed through water, each bubble as it comes into the air bursts into flame and gives off a beautiful wreath of smoke which widens as it ascends.

Phosphorus combines with nitrogen, bromine, iodine, sulphur, etc. The persulphide (PS_{12}, old ; P_2S_{12}, new) is the highest compound in inorganic chemistry.

Phosphorus forms two chlorides—PCl_3, which dissolves phosphorus and is decomposed by water, and PCl_5 (the result of burning P in Cl), which is combustible and is decomposed by water.

Carbon. Symbol, C. Eq. 6, old ; new, 12. Sp. gr. (various).

Carbon is very abundantly diffused throughout nature. It constitutes nearly one-half, by weight, of dried animal or vegetable substances, and is also found abundantly in minerals. Its different varieties are: first, the diamond; second, plumbago or graphite; and third, charcoal. In all its varieties it is more or less combustible, and is infusible and non-volatile, except, perhaps, in the electric arch.

The *diamond*, found chiefly in Brazil, but also in Borneo, India, and Siberia, is the hardest known body. It crystallizes in octohedrons of the first system, and is generally colored. Sp. gr. 3.5. It is a good conductor of heat but not of electricity. It is highly refractive, hence its well-known brilliancy. It may be burnt, when it gives nothing but carbonic acid, and a very little ash ; the last probably an accidental impurity.

Plumbago, Graphite, Black Lead.—This variety is used for lead pencils. The best is found in Cumberland, England, and in

Siberia. It is sometimes found crystallized in hexagonal plates. It is soft and greasy to the touch, has a metallic lustre, and is a good conductor of electricity. Sp. gr. 1.9 to 2.5. 96 per cent. of it is pure carbon. It is formed artificially in the manufacture of cast iron. *Plumbagine* or the carbon of gas retorts is extremely hard, and is much used for the carbon points of electric batteries.

Charcoal is carbon without any crystalline form. There are four general varieties.

Wood charcoal is obtained by heating wood to a high temperature out of contact with the air. It is a black, shining, insoluble substance, without taste or smell. It is a good conductor of electricity, but a bad one of heat. Sp. gr. 1.7. Newly-made charcoal absorbs many times its volume of various gases and vapors, thus promoting their combination, and is hence valuable as a disinfectant. Putrescent animal matter may by its aid be deprived of all its offensiveness. It also removes the taste and color from many solutions, but is not so powerful as animal charcoal in this respect.

Animal charcoal (*bone black—ivory black*) is obtained by charring bones or blood. It removes the taste and color from most organic solutions, and from all vegetable bitters except picric acid, and is therefore very valuable as an antidote to vegetable and animal poisons.

Lampblack is obtained from the destructive distillation of refuse rosin, coal tar, oils, etc. It has less lustre and less active properties than the other varieties of carbon.

Coal.—Coal is fossil wood carbonized; in *lignite* the structure of the wood can be seen. *Bituminous* coal is coal rich in oily matters, and when distilled it leaves as a solid residue *coke*. *Anthracite* is hard coal.

Carbon has a powerful deoxidizing power. Even when cold it reduces the salts of copper, silver, gold, and some others; but when hot it reduces water, soda, potassa, etc.

Its compounds with the metals are called *carbides*, of which the only one of importance is cast iron—a variable carbide of iron.

Tests.—When free, its insolubility in all menstrua, fixedness in close vessels, and its almost entire combustion in air, with the formation of carbonic acid. In compounds, by the formation of carbonic acid when deflagrated with oxide of copper, and in organic compounds by its leaving a black residue when heated in a close vessel.

Carbon and Oxygen.

According to the old chemistry, there are three important compounds of these two elements—carbonic oxide, carbonic acid, and oxalic acid. The new system, however, regards oxalic acid as containing hydrogen: $C_2H_2O_4 = C_2O_2\,(HO)_2 = C_2O_3\,(H_2O)$. Carbon and oxygen do not unite directly under a red heat, except when they are brought together in the nascent state.

Carbonic Oxide, *carbon monoxide* (CO).—CO is formed when carbon is burnt with an insufficient supply of oxygen. It may be procured by heating oxalic acid with sulphuric acid. The CO_2 is absorbed by passing the mixed gas through a solution of lime or

potassa. The best method, however, is to heat powdered ferrocyanide of potassium with eight or ten times its weight of sulphuric acid.

Properties.—Carbonic oxide is a tasteless, odorless, colorless, permanently elastic gas. It burns with a blue flame, producing carbonic acid. It is a narcotic poison. Sp. gr. .96. It is sparingly soluble in water. In combination with chlorine it forms *phosgene* gas.

CARBONIC ACID, *carbon dioxide, carbonic anhydride, fixed air* (CO_2).—This gas is formed by the decomposition of a carbonate by an acid. It is the product of the combustion of carbon with sufficient oxygen.

Properties.—It is a colorless, odorless gas, neither combustible nor a supporter of combustion. It is a narcotic poison. A mixture of $\frac{1}{5}$ of CO_2 and $\frac{1}{5}$ O will not support life. It constitutes the *choke-damp* of mines. It is the principal product of respiration. Sp. gr. 1.52. By a pressure of 38.5 atmospheres it is liquefied at 33°, and solidified at —70°. Water at 60° absorbs its volume of the gas, and by pressure may be made to absorb five or six times its volume. Mineral or aërated water is water impregnated with CO_2 by pressure. It does not combine with water.

Tests.—Extinguishes flame, and produces a milky precipitate in lime-water.

OXALIC ACID will be described under organic chemistry.

Carbon and Hydrogen (Hydrocarbons).

The compounds of these two elements are exceedingly numerous and various. They all belong to organic chemistry, but two are usually included among inorganic compounds, viz., light carburetted hydrogen and olefiant gas.

LIGHT CARBURETTED HYDROGEN, *Methane, Marsh Gas, Fire Damp* (C_2H_4, old; new, CH_4).—This gas is the product of the decomposition of vegetable matter. It is found in stagnant pools, etc. (marsh gas), and is also found in coal mines (fire damp). It is made artificially by the decomposition of acetates.

Properties.—It is a tasteless, odorless, colorless, inflammable gas. It is not poisonous if diluted with air. Sp. gr. .552. It is the chief ingredient of *coal gas*, which is procured by the destructive distillation of coal.

OLEFIANT GAS, *Bicarburetted Hydrogen, Ethylene, Ethene* (C_4H_4, old; new, C_2H_4).—This gas is prepared by heating one measure of alcohol with two measures of concentrated sulphuric acid. The action of the acid is catalytic. The process is complicated, owing to the formation of sulphethylic acid. The operation may be made continuous by passing vapor of alcohol through heated sulphuric acid. The products are separated by passing them through wash bottles.

Olefiant gas is formed in the distillation of rosin, oil, coal, etc.

Properties.—It is a colorless, neutral gas. It is a narcotic poison. It is soluble in about twelve times its bulk of water, sp. gr. .9874. It has been liquefied, but not solidified.

With twice its volume of chlorine, it burns with the formation of chlorohydric acid and the deposition of carbon. With an equal volume, it forms an oily liquid; hence its name of olefiant gas.

COAL GAS.—This is ordinarily manufactured from bituminous coal; but it is sometimes obtained also from wood, rosin, or oil. Its most abundant ingredient is light carburetted hydrogen; more valuable, is a smaller amount of olefiant gas. Also, it contains hydrogen, carbonic oxide (CO), nitrogen, a small amount of bisulphide of carbon, and various combustible hydrocarbons. By the processes of purification, there are absorbed from it (mostly now by a mixture of oxide of iron and sawdust) tar and several volatile oils, and compounds of ammonia, sulphuretted hydrogen, carbonic acid, hydrocyanic acid, or cyanide of ammonium, and sulphocyanide of ammonium. Imperfect purification allows some of these deleterious ingredients to enter the illuminating gas. When breathed it is always poisonous.

Carbon and Nitrogen.

CYANOGEN (C_2N, old; C_2N_2, or CN, new; also Cy) is so named from being a constituent of Prussian blue. It was discovered by Gay-Lussac, in 1814. When carbon is heated in the presence of nitrogen, together with potassa, the C and N combine to form cyanogen, which unites with the metal. In the laboratory, it is generally procured by heating cyanide of mercury.

Properties.—It is a colorless, highly poisonous gas, of a peculiar penetrating odor. It burns with a purple flame, sp. gr. 1.796. It is soluble in water and alcohol. It is liquefied by a pressure of four atmospheres, and at —30° is solidified.

Cyanogen is a *compound radical.* In its chemical properties it resembles chlorine, bromine, etc., and it is classed with them in the halogen group. It unites with hydrogen to form an acid, and directly with the metals to form salts. It also combines with oxygen, sulphur, etc., giving important compounds. The following gives a view of them:—

Names.	Names of Compounds.
Cyanogen,	Cyanide.
Cyanic acid,	Cyanate.
Fulminic acid,	Fulminate.
Cyanuric acid,	Cyanurates.
Cyanohydric acid,	Cyanide.
Sulphocyanogen,	with H, sulphocyanohydric acid. " M, sulphocyanide.
Ferrocyanogen,	" H, ferrocyanohydric acid. " M, ferrocyanide.
Ferricyanogen,	" H, ferricyanohydric acid. " M, ferricyanide.
Nitroferricyanogen,	" H_2, nitrocyanohydric acid. " M_2, nitroprusside.

Of these only cyanogen, cyanuric acid, and cyanohydric acid have been isolated.

CYANOHYDRIC ACID, *Hydrocyanic* or *Prussic Acid* (HCy).—Hydrogen and cyanogen do not combine directly. The free acid is obtained by the decomposition of a cyanide; generally, by distilling ferrocyanide or cyanide of potassium with dilute sulphuric acid.

Properties.—It is a colorless liquid, with the odor of bitter almonds. Its vapor is highly poisonous, while the anhydrous acid is the most powerful poison known. It freezes at 4° and boils at 80°. The sp. gr. of the concentrated acid is .7058. It is a weak acid, and very liable to decomposition; the concentrated spontaneously, the diluted by the action of light.

It is contained among the products of the distillation of bitter almonds, peach leaves and kernels, and laurel leaves. It is found in the juice of the tapioca plant.

Tests.—Its odor; with nitrate of silver, a white precipitate not darkened by light. With sulphide of ammonium, it forms sulphocyanide of ammonium, which gives a red color with persalts of iron. With ferrous sulphate followed by a solution of potassa, it gives a green color, which becomes Prussian blue on the addition of chlorohydric acid.

Ferrocyanogen, etc., will be described under *Iron*.

Carbon and Sulphur.

Bisulphide of Carbon, *sulphocarbonic acid* (CS_2), or *carbon disulphide*, is prepared by the action of vapor of sulphur on red-hot carbon or by distilling iron pyrites with carbon.

Properties.—It is a colorless, highly refractive liquid, of a pungent taste and fetid, sulphurous smell. Sp. gr. 1.272. It boils at 110°, but has not been frozen. It is a narcotic poison. It is useful as a solvent of sulphur and phosphorus. It is a feeble acid, and unites not with *oxygen* but with *sulphur* bases; making salts called *sulphocarbonates;* differing from carbonates in having the oxygen replaced by sulphur.

Boron. Symbol, B. Eq. 11.

Boron is found native only as boracic acid (in Tuscany), which is generally combined with an alkaline or earthy base. Borax ($NaO,2BO_3$, old; $Na_2O,2B_2O_3$ new) is found in India and California.

Boron is obtained by heating boracic acid with potassium or sodium. Aluminium may be used to decompose the acid, but the operation is then much more difficult. It may also be obtained from borofluoride of potassium.

Properties.—Boron is found in three allotropic modifications: the crystalline $B\alpha$, the graphitoid $B\beta$, the amorphous $B\gamma$.

Amorphous $B\gamma$ is an olive-colored, inordorous, insipid substance. It is not a conductor of electricity, and is almost infusible. It is not oxidized by exposure to air, water, or an alkaline solution.

$B\beta$ and $B\alpha$ are formed by heating $B\gamma$ with aluminium in a crucible.

Boracic or Boric Acid (BO_3, old; $B_2O_3 3H_2O$, new).—Found native, combined with soda as borax, and uncombined, in lagoons, in Tuscany, when the native solutions are evaporated and the acid crystallized. It is also procured by decomposing borax by an acid.

The crystallized acid contains three equivalents of water. It is soluble in three parts of boiling water as well as in alcohol. It imparts a green color to flame. It has but little taste, and is a fee-

ble acid. It is much used as a flux on account of the ready fusibility of its compounds.

Tests.—Green color to alcohol flame. Fusibility and fixedness before the blowpipe. Slight solubility in hot water.

Compounds of boron not much known, are its *nitride*, *chloride*, *bromide*, and *fluoride*.

Silicium or **Silicon.** Symbol, Si. Eq. 28.

Silicon is very abundantly diffused throughout nature in the form of silicic acid, which is often found pure as quartz and sand and combined as clay, feldspar, etc. Silicic acid is also found in the animal and vegetable kingdoms.

It is obtained by the decomposition of the silico-fluoride of potassium by heating it with potassium.

Properties.—Like boron, silicon has three allotropic modifications: *Amorphous* silicon ($Si\gamma$), a brown insoluble powder, non-conductor of electricity and burning when heated in the air. *Graphitoid* ($Si\beta$), which very closely resembles $B\beta$, does not take fire in the air, more dense than $Si\gamma$, and is a conductor of electricity. *Crystallized* $Si\alpha$.

Silicon and Oxygen.

Silicon forms but one oxide, silica.

SILICA, *Silicic Acid*, or *Silex* (SiO_3, old; new, SiO_2).—Found abundantly in nature as sand, quartz, etc., in granite, feldspar, clay, etc., in stalks of grapes, joints of bamboo, etc., in hair, and in the skeletons of some infusoria.

Quartz is pure silica; chalcedony, carnelian, onyx, agate, and flint impure. Opal contains water.

Silica may be obtained chemically pure by combining powdered rock crystal by heat with potassa or soda, and then precipitating with chlorohydric acid, or by passing fluosilicic acid through water.

There are two varieties, the amorphous (hydrate), obtained by precipitation, and the crystalline, found native.

Silica is insoluble in water, has no action on vegetable colors, is tasteless, and cannot be melted except by the heat of the oxy-hydrogen blowpipe. The only acid which dissolves it is the fluohydric. Sp. gr. 2.66. Combined with potassa or soda and other bases, it forms glass or porcelain. Lime, oxide of lead, etc., are used to make glass insoluble and less fusible. Silicates of *single* alkaline bases are more or less soluble. Glass has an *excess* of silica.

FLUORIDE OF SILICON, *fluosilicic acid* (SiF_3, old; new, SiF_4), is obtained by heating pulverized fluor spar, powdered glass, or silica with sulphuric acid. Fluohydric acid is at first evolved, which attacks the glass or silica and forms fluosilicic acid.

It is a colorless gas, of a sour taste, and is decomposed by contact with water, forming hydrofluosilicic acid.

The silica is deposited in a gelatinous state, while the hydrofluosilicic acid remains in solution.

Silica in minerals is detected in this way, by finding whether fluosilicic acid can be formed from them.

CHAPTER III.

METALS.

SECTION I.

GENERAL PROPERTIES OF METALS.

THE metals are occasionally found *native*, as gold, silver, copper, platinum, etc.; but more frequently, combined with oxygen and sulphur, and sometimes as salts.

Common Properties.—All possess a certain lustre called *metallic;* are conductors of heat and electricity; are opaque; are positive electrics; are generally good reflectors of light. They vary greatly in specific gravity—from lithium, 0.593, to platinum, 21.50. Some are *malleable*, as gold, silver, tin, lead, etc.; these also are *ductile*. Some possess *tenacity*, as iron; some are *brittle*, as antimony, arsenic, etc.; some are *soft*, as potassium, etc.; whilst others are very *hard*, and even *crystalline*. They differ also much in *fusibility* —from mercury, which is fluid at —39° F., to platinum, which is infusible at the heat of a smith's forge.

Chemical Relations.—With each other they unite to form *alloys;* when mercury forms an alloy, it is termed an *amalgam*. Their chief attraction is for oxygen, though they vary very much in this respect. Some, as potassium, decompose water at ordinary temperatures; others, as iron, at a red heat; others, as silver, gold, and platinum, will only combine with oxygen indirectly. Palladium absorbs (or *occludes*) 900 times its own bulk of hydrogen. The term *noble* has been given to such metals as do not tarnish on exposure to air. Some are oxidized by heating them in the open air; others by deflagration with nitrate, or chlorate of potassium; others, again, by nitro-muriatic acid.

The oxides of metals are generally basic; the *protoxide* is the most powerful base; the sesquioxide is a feeble one; the higher oxides are generally *acid.*

The *sulphides*, *chlorides*, and *iodides* generally correspond in number with the oxides.

Metallic oxides are *reduced* either by heat alone, or by heat and some deoxidizing agent, as carbon or hydrogen; thus, iron ores are reduced by burning them with carbon and lime (the latter acting as a flux with the silex); also, by galvanism; and by precipitation from their solutions by other metals.

The combination with *sulphur* is effected by heating them together; or by heating the oxide and sulphur together; or by heating a sulphate with combustible matter.

Phosphorus and carbon, as well as hydrogen, occasionally unite with metals.

SECTION II.

CONSTITUTION OF SALTS.

Definition.—According to the *old* method of statement, a salt is a compound of an acid with a base, as *sulphate of soda;* or of a halogen with a metal, as *chloride of sodium*, *iodide of potassium*, etc. The first class are termed *oxysalts* (or rather *amphigen salts*); the second, *haloid salts.* The amphigen salts comprise those formed by the amphigen bodies, oxygen, sulphur, selenium, and tellurium; each one of these forms a series of salts, in which the amphigen exists, both in the acid and in the base. Thus, in sulphate of potassa (an oxysalt), the oxygen is found in the sulphuric acid and in the potassa. So in a sulphur salt, we have a sulphur acid and a sulphur base—the former being the sulphide of an electro-negative metal, as arsenic, antimony, etc.; the latter, a sulphide of an electro-positive metal, as potassium, sodium, etc.

It has also been found that two haloid salts will unite together to form what is termed a *double haloid salt*, which also may be considered precisely analogous to an oxysalt; the halogen element, chlorine, iodine, etc., taking the place of oxygen.

Normal Salts.—The rule in regard to the constitution of oxysalts is that they must contain as many equivalents of acid as there are of oxygen in the base; thus, for a protoxide, *one*, as $FeOSO_4$; for a sesquioxide, *three*, as $Fe_2O_3,3SO_3$. Such salts are usually termed *neutral.* When the proportion of acid is not so great as that indicated, a *subsalt* is formed—as $2Fe_2O_3,5SO_3$, subsulphate of sesquioxide of iron (Monsel's salt).

A *double salt* is one in which the same acid is united with two separate bases, as tartrate of soda and potassa (Rochelle salt), and tartrate of antimony and potassa (tartar emetic).

For the above statements, under the *new* chemistry, we must substitute the following: An oxygen *salt* is a ternary compound, in which an electro-positive element (as a metal) is, by means of oxygen, united to an electro-negative element, as, for instance, sulphur. An oxygen *acid* is a *hydrogen salt; e. g.*, sulphuric acid, SO_4H_2. An oxygen *base*, or basic oxide, is a *hydrated* oxide; *e. g.*, KHO, or potassium combined with *hydroxyl*, HO. In forming the *salt*, potassium sulphate, SO_4, unites with K_2 of two equivalents of the hydrate, making SO_4K_2; the potassium displacing the hydrogen of the acid, or *hydrogen sulphate*, SO_4H_2. Or, again, when sulphuric acid acts on zinc, we have the zinc displacing the hydrogen of the acid: $SO_4H_2 + Zn = SO_4Zn + H_2$; *i. e.*, zinc sulphate *plus* free hydrogen gas, which escapes or may be collected. Saline properties also belong to bodies in which the *halogen* elements are combined with metals; as sodium chloride, potassium iodide, etc. Further, there are salts analogous to the oxygen salts, in which *sulphur*, *selenium*, or *tellurium* unites two other elements, which are electro-positive and electro-negative towards each other. The exact constitution (or molecular arrangement) of these salts is not absolutely certain. Thus, hydrogen sulphate (or sulphuric acid) may be regarded either as SO_4,H_2, SO_3H_2O, $SO_2(OH)_2$, or SH_2,O_4.

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Acids are monobasic, bibasic, or tribasic (polybasic), according to their containing one, two, three, or more atoms of hydrogen replaceable by metals. Thus hydrochloric (HCl), nitric (HNO_3), and boric (BO_2H) are monobasic acids; sulphuric (SO_4H_2) and carbonic (CO_3H_2) bibasic; orthophosphoric (PO_4H_3) tribasic; pyrophosphoric ($P_2O_7H_4$) tetrabasic.[1]

Nearly all salts are solid at common temperatures; most are crystallizable; their color is variable. The soluble ones are more or less sapid; very few are odorous. They differ much in their affinity for water, some attracting moisture from the air so as to liquefy (*deliquescent*), while others give out their water to the air (*efflorescent*). They vary also in their solubility in water.

As a rule, each salt possesses its own *crystalline form*, by which it may be recognized.

Crystallization may be effected in various ways: (1), by solution in water, and evaporation; the slower the evaporation, the larger and more regular will be the crystals; (2), fusion and slow cooling, as in the case of sulphur and bismuth; (3), in passing from the gaseous to the solid state, as in the case of iodine.

Many salts, in crystallizing, unite *chemically* with a definite quantity of water, which belongs to the crystal but not to the salt; this is termed *water of crystallization*. By a strong heat, all this water is expelled, and the salt is said to undergo the *watery fusion*. A familiar illustration is afforded in the preparation of *dried alum*. Such salts, when exposed to the air, are liable to part with a portion of this water, and crumble down into a powder, which is termed *efflorescence*. Others contain water still more intimately connected with their composition, called *constitutional water*. Some salts again, in crystallizing, inclose a portion of water *mechanically* within their texture, which by expansion, when heated, causes the crystal to burst with a crackling noise; this is termed *decrepitation*.

Crystals are of various forms. They are divided by crystallographers into *simple* and *compound*. By *cleavage* is meant that property of a crystal which admits of its being split in certain directions.

Isomorphism.—Certain bodies of similar chemical constitution have the power to replace each other in crystalline compounds, without altering their crystalline form. In many instances, these compounds have the same color and taste. Such bodies are said to be *isomorphous*. Examples of isomorphism are afforded in the alums, in which the sesquioxides of aluminium, iron, manganese, and chromium, as well as potassium, sodium, and ammonium, replace each other so perfectly, as to present a complete identity in appearance and in general properties. The salts of phosphoric and arsenic acids are also isomorphous. On the other hand, the same substance may present, under different circumstances, two distinct crystalline forms, in which case it is said to be *dimorphous;* sulphur is an example of dimorphism; carbon is *trimorphous*.

[1] In organic chemistry, oxalic and tartaric acids are bibasic; citric acid is tribasic.

SECTION III.

CLASSIFICATION OF THE METALS.

CLASS I. Metals of the Alkalies.
CLASS II. Metals of the Alkaline Earths.
CLASS III. Metals of the Earths.
CLASS IV. Metals Proper.

CLASS I.

METALS OF THE ALKALIES.

THIS class of metals includes *Potassium*, *Sodium*, *Lithium*, and *Ammonium*.

Potassium. Symb. K. Eq. 39.1.

Exists naturally in certain rocks and minerals, as felspar, mica, and clay. By gradual disintegration, these dissolve, and the potassa is absorbed into the earth, whence it is taken up by the roots of plants; and from the ashes of these it is finally procured by lixiviation, as impure carbonate (*pot* and *pearl-ashes*).

Originally discovered by Davy in 1807, by the agency of galvanism.

Prepared by heating the carbonate, along with charcoal, to whiteness; the potassium distils over, with carbonic monoxide.

Properties.—A brilliant bluish-white metal; soft at common temperatures; crystalline at 32°; melts at 130°; sp. gr. 0.865; has so strong an affinity for oxygen that it cannot be preserved in the open air; must be kept under naphtha. Thrown on water, the latter is decomposed, the oxygen uniting with the metal to form the protoxide, and the hydrogen, being set free, along with some of the potassium takes fire, and burns with a violet flame. It forms compounds with oxygen.

PROTOXIDE, *potassa*, KO (new method, K_2O, *potassium monoxide*), is formed by burning potassium in dry air. It is a white solid, anhydrous, very caustic, and has a powerful affinity for water.

Hydrate of potassa, KO,HO (new method, KOH), also called *common caustic* and *potassa fusa*, is prepared by boiling together carbonate of potassium and caustic lime; strain off the carbonate of lime which is formed, evaporate to a proper consistency, and then pour into iron moulds. Pure hydrate of potassa is a white solid, very deliquescent,[1] soluble in water and alcohol. The solution, like lime-water, absorbs carbonic acid from the air. The solid hydrate is used to free gases from hygrometric moisture. In medicine, it is used as an escharotic; also in solution (*liquor potassæ*).

[1] *Deliquescent*, absorbing moisture from the air, and becoming liquid by solution therein. *Efflorescent* mineral substances *give off* moisture, and fall into dry powder. Potassium carbonates deliquesce, sodium carbonates effloresce.

TEROXIDE, KO_3; new method, *tetroxide*, K_2O_4; is formed when potassium is burned in an excess of dry oxygen gas. It is of an orange color.

There is also said to be a *dioxide* (new system, K_2O_2); but it has not been isolated.

Salts of Potassium.

Carbonate (KO,CO_2, old; new, K_2CO_3).—In the impure state of *pot* and *pearl-ashes*, it is manufactured by lixiviating the ashes of inland plants, and evaporating to dryness. By redissolving in cold water and evaporating, the *common* carbonate is obtained—a white granular deliquescent body of nauseous taste and alkaline reaction. The pure carbonate (*salt of tartar*) is made by decomposing cream of tartar at a high heat, or by igniting the bicarbonate.

Bicarbonate ($KO,HO,2CO_2$, old; new, $KHCO_3$).—Obtained by passing a stream of carbonic acid through a solution of the carbonate, and evaporating. It is crystalline, less soluble than the carbonate, but more free from impurities. *Sal æratus* is the old name for the bicarbonate. In the arts, the carbonate is used for making soft soaps and glass.

Sulphate (KO,SO_3, old; new, K_2SO_4).—The residue from making nitric acid on a large scale. *Bisulphate* ($KO,HO,2SO_3$, old; new, $KHSO_4$) is more soluble, and has an acid reaction. There is also another acid sulphate, difficult of production.

Nitrate (KO,NO_5, old; new, KNO_3), called *nitre* and *saltpetre*, made by the action of nitric acid on carbonate of potassium; occurs native as an efflorescence in certain earths, also as an incrustation in caverns; manufactured from *artificial nitre-beds*. Crystallizes in six-sided prisms; very soluble; these contain water mechanically confined, which causes them to *decrepitate* when thrown upon hot coals. Heated, it gives off oxygen, becoming converted into a hyponitrite or nitrite. A very high heat entirely decomposes it. From its facility in imparting oxygen, it constitutes an active ingredient in *gunpowder*, which is a mixture of nitre, sulphur, and charcoal in certain proportions. When gunpowder is fired, the oxygen of the nitre combines with the carbon to form carbonic oxide and carbonic acid, the sulphur unites with the potassium, and the nitrogen is set free. The result is an extraordinary rise in temperature and a tremendous expansive force.

Chlorate (KO,ClO_5, old; new, $KClO_3$).—Made by passing chlorine gas through a weak solution of potassa. It is remarkable for its powerful deflagrating powers. Heated, it yields up all its oxygen. Used for making friction matches and fuses.

Silicate.—Silicic acid unites in different proportions with the alkalies. If the base be in excess, a soluble salt is formed, termed soluble glass (*liquor silicium*). If the acid be in excess, an insoluble salt (*glass*) is the result. Glass generally contains a mixture of potash, soda, and lime. Oxide of lead is employed, also, in *flint* glass. It is colored by admixture with the different metals, as *green* by the oxide of iron; *blue*, by cobalt; *ruby*, by the red oxide of copper; *purple*, by the purple of Cassius; *amethyst*, by manganese, etc.

Chloride, KCl.—Obtained in making the chlorate; the latter

salt crystallizes and separates, leaving the chloride in solution, from which it can be procured in the solid state. It much resembles chloride of sodium in its properties.

Iodide, KI.—Made by dissolving iodine in a strong solution of caustic potassa; also, by digesting together iodine, iron, and water; iodide of iron is formed, which is afterwards added to carbonate of potassium in solution, when carbonate of iron is precipitated, and iodide of potassium is dissolved. By evaporation, it crystallizes in cubes, white and opaque, very soluble in water, much used in medicine, also in photography.

Bromide, KBr.—Prepared as the iodide, which it much resembles in appearance and general properties.

Sulphide.—This substance, known as *liver of sulphur* (*hepar sulphuris*), is made by heating together sulphur and carbonate of potassium.

Tests.—1. Tartaric acid in excess gives with potash and its salts a granular precipitate—*cream of tartar;* 2. A solution of bichloride of platinum causes a yellow precipitate; 3. Carbazotic acid precipitates the yellow carbazotate of potassium; 4. The salts of potassium impart to the flame of the blowpipe a purple or violet color.

Sodium. Symb. Na. Eq. 23.

History and mode of preparation, the same as of potassium.

Properties.—A bluish-white metal, resembling potassium in most respects; sp. gr. 0.972; decomposes water with great violence, but does not inflame at ordinary temperatures on account of the rapid motion. It is oxidized by water or the air.

SODA (NaO, old; new, Na_2O);—Anhydrous; formed like potassa; properties similar.

Hydrate (NaO,HO, old; new, $NaOH$).—Prepared from the carbonate by the action of lime. Very similar in properties to hydrate of potassium.

There is also another oxide (Na_2O_2, new system) formed when sodium is heated in dry air. It is white, but becomes yellow when heated.

Carbonate (NaO,CO_2, old; new, Na_2CO_3).—Prepared by lixiviating the ashes of marine plants, and evaporating to dryness. This is known commercially as *barilla* and *kelp;* it contains many impurities, among which is *iodine.* A purer variety is manufactured by roasting together, in a furnace, sulphate of sodium, lime, and sawdust. Sulphide of calcium, sulphurous oxide, and carbonate of sodium are formed. It is also manufactured from *cryolite*, a native *double fluoride of sodium* and *aluminium*, found in Greenland. The impure commercial *soda-ash* contains variable quantites of the alkali. Vast quantities of it are used in the manufacture of soap and glass. This salt occurs in large rhombic crystals, efflorescent, very soluble in water; of a caustic alkaline taste, and alkaline reaction.

Bicarbonate ($NaO,HO,2CO_2$, old; new, Na_2HCO_3).—Made by passing carbonic acid over the carbonate. It is a white powder, of an alkaline taste and reaction; less soluble than the carbonate.

The *sesquicarbonate* occurs native. It may be regarded as a compound of the neutral and the acid carbonate.

Sulphate (*Glauber's salt*) (NaO,SO_3 + Aq, old; new, Na_2SO_4 + Aq).—The residue in the process for making hydrochloric acid (sulphuric acid on chloride of sodium); in long colorless efflorescent prisms, of a saline bitter taste; very soluble in water, more so at 90° than at 212°. There is also a *bisulphate*, or acid sulphate.

Sulphite (NaO,SO_2 + Aq, old; new, *hyposulphite*, $Na_2S_2O_3$ + Aq).—Prepared by passing sulphurous acid through a solution of the carbonate.

The *nitrate* occurs native as *cubic nitre;* similar in properties to common nitre.

Phosphates.—The peculiarity of phosphoric acid in combining with one, two, or three equivalents of base, has already been discussed (see PHOSPHORUS). Of the phosphates of sodium there alluded to, the one used in medicine is $2NaO,HO,PO_5$ + Aq, old notation; new, Na_2HPO_4 + Aq.—Prepared by the action of superphosphate of calcium on carbonate of sodium. Large, colorless, efflorescent crystals, with a taste resembling common salt; sparingly soluble in water. Strongly heated, it is converted into the *pyrophosphate.*

Chloride (*common salt*), NaCl.—Is found in sea water and saline springs; also as a mineral, under the name of *rock-salt.* Prepared by evaporating a saline solution. Crystallizes in cubes; soluble in water; somewhat deliquescent; the crystals *decrepitate* when thrown upon hot coals.

Bromine, *iodine*, *fluorine*, and *sulphur* also combine with sodium, forming compounds similar to those of potassium.

Tests.—All the sodium-salts are soluble; they communicate a *yellow* color to the blowpipe or alcohol flame.

Lithium. Symb. Li. Eq. 7.

A rare metal; found in combination, in spodumene, petalite, and in certain mineral waters. Obtained by electrolysis of the fused chloride. It is the lightest solid body known. Sp. gr. 0.594.

The *carbonate* has been introduced into medicine.

Test.—It is distinguished from strontia by the solubility of its salts in sulphuric acid.

Ammonium. (Hypothetical.) Symb. NH_4. Eq. 18.

Ammonium is the hypothetical metal, or radical of *ammonia*, which has already been treated of under the head of compounds of nitrogen and hydrogen. It has never been isolated, but can be procured in the form of the *ammonium amalgam*, by first forming an amalgam of sodium and mercury, and throwing this into a saturated solution of chloride of ammonium; it swells up enormously, and assumes a pasty condition. It speedily decomposes into mercury, ammonia, and hydrogen.

AMMONIA, NH_3.—This has already been described, as a gas. It is formed during the destructive distillation of organic matter, in the presence of nitrogen. On the large scale, it is prepared from the *ammoniacal liquor* of gas works; this is neutralized by sulphuric acid, which converts it into the sulphate, from which all the other compounds may be formed. *Aqua ammoniæ* is made by

heating either the crude sulphate or sal ammoniac with milk of lime, and allowing the gaseous ammonia to be absorbed by water.

Carbonate ($2NH_4O,3CO_2$, *sesquicarbonate*, old system; new, according to Fownes, $(CO_3)_3(NH_4)_4H_2$; Attfield, $N_4H_{16}C_3O_8$, or $2NH_4HCO_3,NH_4NH_2CO_2$).[1]—Obtained by subliming a mixture of sal ammoniac and chalk. Used in medicine. Has a pungent odor and taste; soluble in water.

Sulphate.—Already alluded to as obtained by separation from gas-liquor.

Nitrate.—Used as the source of nitrous oxide gas.

Chloride (*Sal Ammoniac*), NH_4Cl.—Obtained by subliming a mixture of common salt and sulphate of ammonium. It is a white, inodorous, fibrous salt, of a pungent taste; soluble in water; much used in the arts; also in medicine.

Tests.—Any salt of ammonium may be detected by heating a fragment with lime, in a test-tube; the well-known smell of ammonia will be given off. It forms also a white cloud, on being brought into contact with hydrochloric acid gas.

CLASS II.

METALS OF THE ALKALINE EARTHS.

This class includes *Barium*, *Strontium*, *Calcium*, and *Magnesium*.

Barium. Symb. Ba. Eq 68.5, old; new, 137.

Obtained by means of mercury from baryta, by galvanic agency; also by passing the vapor of potassium over red-hot baryta.

Properties.—A white metal; decomposes water at ordinary temperatures; sp. gr. 1.5.

BARYTA, BaO.—Occurs in nature as a carbonate (*witherite*), and a sulphate (*heavy spar*); may be made by heating the nitrate. Has a strong affinity for water, forming the *hydrate*, which is a white powder, resembling slaked lime.

PEROXIDE, BaO_2.—Used in making the peroxide of hydrogen.

The salts of baryta are distinguished for their high specific gravity. The most important are the *carbonate*, *sulphate*, *nitrate*, and *chloride*. The two former are insoluble; the two latter are soluble, and are used as tests.

Test.—Forms an insoluble white salt with sulphuric acid.

Strontium. Symb. Sr. Eq. 44, old; new, 88.

Prepared as barium. Forms two oxides.

STRONTIA, SrO.—Prepared as baryta, which it much resembles. Its other compounds are analogous to those of baryta.

Test.—It communicates a blood-red color to the blowpipe or alcohol flame.

[1] Two equivalents of *bicarbonate* of ammonium, with one equivalent of *carbamate* of ammonium.

Calcium. Symb. Ca. Eq. 20, old; new, 40.

Obtained by the fusion of sodium with the iodide of calcium; or by electrolysis of the fused chloride.

Properties.—A light yellow malleable metal; slowly decomposes water; sp. gr. 1.578; forms compounds with oxygen, chlorine, sulphur, etc.

PROTOXIDE or *Monoxide* (*Lime*, *Quicklime*), CaO.—Obtained by heating the native carbonate in dry air. A grayish-white solid; caustic; infusible; has a strong affinity for water, forming with it a solid hydrate (slaked lime), with the evolution of much heat. The hydrate is slightly soluble in water, forming *lime-water*. Exposed to the air, it attracts carbonic acid; hence it is a good test for this gas. It has an alkaline reaction. The hardening of mortars is probably due to the gradual absorption of carbonic acid from the air, or to the combination of the lime and sand to form a silicate.

Sulphate (native *Gypsum*), CaO,SO_3 or $CaSO_4$.—When crystalline, it is termed *selenite*. If heated and ground it constitutes *calcined plaster*, which is used for taking casts and moulds; also in agriculture. Soluble in 500 parts of water. It is often found in spring waters.

Carbonate, CaO,CO_2 or $CaCO_3$.—Occurs native as *limestone*, *marble*, and *chalk*. Artificially made by decomposing chloride of calcium by carbonate or soda. *Properties.*—Insoluble in water, unless carbonic acid is present; exists in certain spring waters as a supercarbonate; and is often deposited from the roofs of caves as *stalactites*.

Phosphate of lime (phosphate of calcium) exists in bones.

CHLORIDE, $CaCl$, old; new, $CaCl_2$.—Prepared by the action of hydrochloric acid on the carbonate. Distinguished for its great affinity for moisture; hence much used by the chemist for removing water from substances; also employed for forming frigorific mixtures.

Fluoride, $CaFl$, old; new $CaFl_2$, found native as *Derbyshire* or *fluor spar*.

Hypochlorite, commonly named *chloride of lime*, or *bleaching salt*.—Prepared by the action of chlorine upon strata of the milk of lime. Chemically, it is a mixture of hypochlorite and chloride of calcium.

Test.—Oxalic acid forms the insoluble white oxalate of calcium.

Magnesium. Symb. Mg. Eq. 12, old; new, 24.

Obtained by heating the chloride with sodium.

Properties.—Resembles silver in color and lustre; very ductile and malleable. Oxidized by hot water; burns in the air, producing a brilliant white light, and is thereby converted into an oxide. Sp. gr. 1.7.

MAGNESIA, MgO.—Prepared by calcining the carbonate; a soft, white, insoluble powder.

Carbonate, MgO,CO_2 or $MgCO_3$.—Occurs native as *magnesite*. Prepared by double decomposition, as a hydrate. *Magnesia alba*

of pharmacy consists of a combination of the carbonate with the hydrate.

Sulphate (*Epsom Salt*), MgO,SO_3 or $MgSO_4$.—Made by dissolving magnesian limestone in sulphuric acid. Exists in sea-water and in some mineral springs. Very soluble in water; taste, bitter and saline.

Phosphates.—The most important is the *ammonio-magnesian*, or *triple phosphate*, $2MgO + NH_4O,PO_5 + 12HO$ or (new) $Mg(NH_4)PO_4 + Aq$. This constitutes one variety of urinary calculus.

Test.—With phosphate of sodium and ammonium, it throws down the well-known ammonio-magnesian phosphate.

CLASS III.

METALS OF THE EARTHS.

This class includes *Aluminium*, *Yttrium*, *Glucinium*, *Zirconium*, *Thorium*, *Erbium*, *Terbium*, *Cerium*, *Lanthanum*, *Didymium;* together with the metals lately discovered by the spectral analysis, viz., *Rubidium*, *Cæsium*, *Thallium*, and *Indium*.

Aluminium. Symb. Al. Eq. 13.7, old; new, 27.4.

Obtained by decomposing the chloride by means of potassium or sodium.

Properties.—Closely resembles zinc in color and hardness; very malleable and ductile; sp. gr. 2.5; very difficult to fuse; used as a substitute for silver. When burned in the air, it forms alumina.

ALUMINA, Al_2O_3.—Exists abundantly in nature as a constituent of clays; also in the sapphire, ruby, topaz, etc. Obtained as a hydrate by precipitating its salts by a caustic alkali. By heating the hydrate it may be procured *anhydrous*.

Properties.—A soft, white, tasteless, and inodorous powder; feels pasty to the tongue; very insoluble and infusible; has a strong affinity for water. It has a great attraction for organic colors; is hence used as a *mordant* in dyeing; acts feebly as a base.

The most important salts are the *alums*. Common alum is a double sulphate of alumina and potassa, $Al_2O_3,3SO_3 + KO,SO_3$, old notation; new, $AlK(SO_4)_2$. There is a number of other alums, in which the aluminium is replaced by the sesquioxide of iron, manganese, or chromium; and the potassium, by sodium or ammonium, etc.

Alumina forms the basis of *porcelain* and *earthenware*.

Test.—Caustic alkalies throw down a white gelatinous precipitate (the *hydrate*). Nitrate of *cobalt* imparts to its salts a blue color before the blowpipe.

The other Metals of the Earths are of no particular importance.

CLASS IV.

METALS PROPER.

Order I.—METALS WHOSE OXIDES FORM POWERFUL BASES.

Manganese. Symb. Mn. Eq. 27.5, old ; new, 55.

Occurs in nature as an oxide, from which it is procured by heating with charcoal.

Properties.—A hard brittle metal ; color, grayish-white ; infusible ; sp. gr. 8.013.

PROTOXIDE or *monoxide*, MnO.—A strong base ; forms salts isomorphous with magnesia and zinc, of a rose color.

SESQUIOXIDE, Mn_2O_3.—Native.

DEUTOXIDE or *dioxide* (*black oxide*), MnO_2.—Native ; the most important of all ; much used by the chemist, and in the arts.

MANGANIC ACID, MnO_3.—Cannot be isolated. The *mineral chameleon* is the manganate of potassa (potassium manganate, K_2MnO_4) ; when this is thrown into water it becomes purple, and finally red, from the formation of the PERMANGANATE. This permanganate is manufactured extensively for its use as a *deodorizer* and *disinfectant ;* also for the dyer. It acts by imparting oxygen, or ozone. New formula, $Mn_2K_2O_8$.

Sulphate, $MnOSO_3$.—Rose-colored crystals, very soluble.

CHLORIDE, MnCl (new, $MnCl_2$).—The residue in making chlorine gas.

Tests.—Sulphuretted hydrogen giving a flesh-colored precipitate with any of the salts ; the formation of the *mineral chameleon ;* the amethystine color of the blowpipe flame with borax.

Iron. Symb. Fe. Eq. 28, old ; new, 56.

The most abundant of all metals ; widely diffused throughout nrture, in combination. Rarely found native. In meteorites, with nickel and cobalt. The most abundant iron ores are the *oxides* and *sulphides.* Some of these are magnetic. Iron is extracted from its ores by roasting, and then exposing to a high heat along with charcoal and limestone ; the latter acts as a flux. By this process common *cast iron* is obtained ; this is converted into *soft* or *malleable* iron by exposure to a strong heat and a current of air, termed *puddling.* *Steel* is a *carbide* of iron, made by exposing alternate strata of soft iron and charcoal to an intense heat ; a direct union ensues, by which the iron acquires great hardness. By the *Bessemer* process, malleable iron and steel are made direct from pig iron *without the aid of fuel*, by causing hot air to pass through the liquid metal. The carbon is burnt away as carbonic oxide, and develops in its combustion sufficient heat to continue the operation without the aid of external fire.

Properties.—Has a peculiar gray color ; metallic lustre ; not very malleable ; quite ductile ; the most tenacious metal ; very hard ; of a fibrous texture ; sp. gr. 9.7 ; very infusible ; can be melted ; is attracted by the magnet ; can be rendered magnetic ; does not oxidize in dry air, or in perfectly pure water ; burns

vividly in oxygen; rusts when exposed to air and moisture; decomposes water at a red heat, evolving hydrogen. May be procured pure by passing hydrogen over the oxide, heated to redness, in a tube (*Quevenne's iron*).

PROTOXIDE or *ferrous oxide*, FeO.—The strongest base; can scarcely be isolated, from its great tendency to absorb oxygen; as a *hydrate*, from any of the protosalts by means of an alkali. It is of a dirty-green color, speedily becoming red by the absorption of oxygen from the air.

SESQUIOXIDE (peroxide), Fe_2O_3.—Occurs in nature as *hematite*. Made by dissolving iron in nitro-muriatic acid, and precipitating by an alkali. It has a foxy-red color; is not attracted by the magnet; forms reddish salts.

BLACK or MAGNETIC OXIDE, $FeO+Fe_2O_3$.—A mixture of the two former oxides; occurs native; a very valuable ore for working; does not form salts.

FERRIC ACID, FeO_3.—Cannot be isolated; is obtained as a *ferrate of potassium or barium*.

PROTOCHLORIDE, $FeCl$; new system, *ferrous chloride*, $FeCl_2$.—Made by dissolving iron in hydrochloric acid, and drying.

SESQUICHLORIDE, Fe_2Cl_3, old; new system, *ferric chloride*, Fe_2Cl_6.—Prepared as the former, with addition of nitric acid; also by burning iron in chlorine gas.

There are two iodides; the protiodide, used in medicine, is made by digesting iron wire and iodine in water.

PROTOSULPHIDE, FeS.—Prepared by heating iron and sulphur together.

BISULPHIDE, FeS_2.—Occurs native; called *fool's gold*, from its yellow color.

Magnetic iron pyrites is a native ore, composed of the proto- and bisulphides (Stromeyer).

Cyanogen forms important double salts with iron.

Ferrocyanide of Potassium, Yellow Prussiate of Potash, $2K,FeCy_3$, old; new, K_4FeCy_6, is made by heating cyanide of potassium with iron. A compound radical, *ferrocyanogen*, is supposed to be formed in the process, of which the symbol is $FeCy_3$, old; new, $FeCy_6$.

Ferrocyanide of Iron, Prussian Blue, $3FeCy_3 + 4Fe$, old; new, Fe_7Cy_{18}, made by adding ferrocyanide of potassium to any persalt of iron.

Ferricyanide of Potassium, Red Prussiate of Potash, Fe_2Cy_6+3K, old; new, K_3FeCy_6.

Ferricyanide of Iron, Turnbull's Blue, $Fe_2Cy_6 + 3Fe$, old; new, $Fe_3Fe_2Cy_{12}$, is made by adding the red prussiate to a protosalt of iron. These last two compounds contain the compound radical *ferricyanogen*, Fe_2Cy_6, old notation.[1]

Carbonates.—An alkaline carbonate added to a ferrous (protoxide) salt, throws down a white hydrated carbonate, which speedily absorbs oxygen from the air, and passes into the sesquioxide. This may be partially prevented by the addition of honey

[1] Fownes does not accept as valid the assumption of the existence of the supposed radicals ferrocyanogen and ferricyanogen. If they do exist, the relative number of atoms of their elements is the same in both.

and sugar. *Vallet's mass* is thus prepared. The carbonate is found native; it exists in chalybeate springs. There is no higher carbonate.

Protosulphate or *ferrous sulphate* (*green vitriol*), FeO,SO_3, old; new, $FeSO_4$.—Made by the action of dilute sulphuric acid on iron. Occurs in beautiful green crystals, very soluble in water; efflorescent; isomorphous with sulphate of magnesia. There is also a *ferric sulphate;* on the new system, $Fe(SO_4)_3$.

There are two *nitrates.*

Tests.—For the *ferrous salts:* alkalies and their carbonates throw down a dirty greenish or whitish precipitate, which speedily becomes reddish; red prussiate of potash gives *Turnbull's* blue.

For the *persalts* or *ferric salts:* alkalies and their carbonates precipitate the red oxide; yellow prussiate of potash gives *Prussian blue;* tannic acid strikes a blue-black color; the sulphocyanides produce a blood-red color.

Copper. Symb. Cu. Eq. 31.7, old; new, 63.4.

Occurs native; also as an oxide, sulphide, and carbonate; obtained from the sulphide by roasting with charcoal.

Properties.—The only red metal except titanium; sp. gr. 8.6; very ductile; malleable and tenacious; undergoes but little change in dry air, but when moist becomes covered with the *subcarbonate.*

DIOXIDE or *cuprous oxide* (*suboxide, red oxide*), Cu_2O.—Occurs native in crystals. Formed by heating together the black oxide and copper filings. It is also precipitated in the presence of *grape-sugar* from a protosalt by potassa.

PROTOXIDE or *cupric oxide* (*black oxide*), CuO.—The basis of most of the salts. Prepared by heating the nitrate; as a hydrate, by precipitating any protosalt by potassa; also by calcining metallic copper.

There is also a PEROXIDE, CuO_2, very unstable.

There are also two *chlorides, iodides,* and *sulphides* of copper, similar in composition to the first two oxides.

Sulphate (*blue vitriol*), CuO,SO_3, or $CuSO_4$.—Made by boiling copper in oil of vitriol; on a large scale, by roasting copper pyrites. Occurs in large rhomboidal blue crystals; very soluble in water.

The *carbonate* occurs native as *malachite.*

The *subacetate* (*verdigris*) is made by exposing sheets of copper to the refuse of grapes. Its composition is variable.

Tests.—All the cupreous salts are either *blue* or *green*-colored. Ammonia, in small quantities, precipitates the white hydrated oxide; but if added in excess, the precipitate is redissolved, and a rich purplish-blue solution is formed. Ferrocyanide of potassium gives a rich claret-colored precipitate. A piece of iron or steel precipitates the pure copper in the metallic form.

Copper forms several important *alloys,* as bronze, brass, bell-metal, etc. Although the proportions used are not constant, the composition of the principal alloys in common use is as follows: Brass, 2 parts of copper and 1 of zinc; bronze, 9 copper, 1 of zinc, and 1 of tin; bell-metal, 3 copper and 1 tin; speculum metal, 2

copper and 1 tin; German silver, 10 copper, 6 zinc, and 4 nickel; type-metal, lead, antimony, and tin, in several different proportions; Britannia metal, 50 tin, 4 antimony, 4 bismuth, and 1 copper.

Lead. Symb. Pb. Eq. 103.5, old; new, 207.

Procured chiefly from the native *galena* (sulphide) by roasting.

Properties.—A soft, bluish metal, having a metallic lustre when freshly cut; speedily tarnishes on exposure; malleable and ductile, especially in the form of *pipe;* sp. gr. 11.45; melts at 600°; is not rusted by perfectly pure water, but in common water is partially converted into the carbonate. Exposed to moist air, it is covered with a film of *dioxide;* melted in the air, it is converted into the protoxide. It forms four oxides.

SUBOXIDE, Pb_2O.—Made by heating the dried oxide.

PROTOXIDE, *or monoxide*, PbO (*litharge, massicot*).—Prepared by exposing melted lead to the action of the air. It is a powerful base, forming numerous salts. As a white hydrate, it is thrown down from its salts by an alkali.

PEROXIDE (*puce*, or *brown oxide*), PbO_2.—Prepared by the action of nitric acid on red lead; it has a flea-color, and is insoluble in water; heat converts it into protoxide and oxygen.

Red Lead (*minium*), Pb_3O_4, or $2PbO + PbO_2$.—Considered to be a compound of the two preceding oxides. It is formed by exposing the protoxide to heat, without fusing. A heavy, brilliant, red powder. It is decomposed by a high heat into oxygen and protoxide; used as a pigment, and in glass manufacture.

Chlorine forms with lead the compound known as *plumbum cornum*, or *horn-lead.*

Sulphur forms with it the well-known *galena*, a native sulphide, which occurs in beautiful cubic crystals.

Iodine, bromine, fluorine, and phosphorus also form compounds with lead.

The most important salts are the carbonate and acetate.

Carbonate (*white lead*), PbO,CO_2, or $PbCO_3$.—Occurs native; made on a large scale by exposing sheets of lead to the vapors of vinegar in a hot-bed; the subacetate is first formed, which is subsequently converted into the carbonate; as a hydrate, by precipitating the acetate by an alkaline carbonate.

Properties.—A soft, white, very heavy powder, insoluble in pure water; much used as a pigment.

Acetate (*sugar of lead*), $PbO,C_4H_3O_3$, old; new, $Pb2(C_2H_3O_2)$.—Made by dissolving litharge in acetic acid; on the large scale, prepared by exposing leaden plates to acetic acid. Occurs in colorless transparent crystals; of a sweetish, astringent taste; soluble in water and alcohol.

There are several *subacetates*, made by boiling the neutral acetate with litharge. *Goulard's extract* is chiefly the *trisacetate* (old system).

The *nitrate*, prepared by the action of nitric acid on lead, is soluble.

The *sulphate* is a white insoluble powder.

Tests.—The alkaline carbonates precipitate *white lead;* the alkaline sulphates, or sulphuric acid, throw down the *white* sulphate;

iodide of potassium and chromate of potassium, each, throws down a *yellow* precipitate; sulphuretted hydrogen gives the *black* sulphide (very delicate).

Zinc. Symb. Zn. Eq. 32.5, old; new, 65.

The most common ores of zinc are the *sulphide* (blende), *carbonate* (calamine), and *silicate*. Obtained, by roasting and reduction; the vapor comes over by distillation.

Properties.—A bluish-white metal (termed *spelter* in commerce); crystalline; brittle; sp. gr. 7; melts at 773°; malleable at 300°; very brittle again at 400°; at a bright red heat it burns, emitting a brilliant green light, and forming the oxide.

OXIDE, ZnO.—Obtained by burning zinc in the air; as a hydrate, by precipitating a salt of zinc by potassa, or by heating the carbonate; it is a white, insoluble powder.

CHLORIDE, ZnCl, old; new, $ZnCl_2$.—Prepared by burning zinc in chlorine, or by dissolving it in hydrochloric acid. It is a white substance, deliquescent and caustic.

Sulphate (*white vitriol*), $ZnOSO_3$, or $ZnSO_4$.—Made by the action of dilute sulphuric acid on zinc; a white crystalline salt, very soluble in water; of a styptic taste. Used in medicine, as an emetic and astringent.

Carbonate, ZnO,CO_2, or $ZnCO_3$; is found native as *calamine*; made by the action of carbonate of soda on sulphate of zinc.

Test.—Sulphide of ammonium throws down a *white* sulphide.

Cadmium. Symb. Cd. Eq. 56, old; new, 112.

This metal is usually found associated with zinc. It much resembles tin in appearance and general characters. It is volatile; sp. gr. 8.7; melts below 500°.

Test.—Sulphuretted hydrogen gives a *yellow* precipitate, distinguished from sulphide of arsenic, by being dissolved in an acid, but not in an alkali.

Bismuth. Symb. Bi. Eq. 210.

Occurs native, and as an oxide. Obtained by heating the subnitrate with charcoal.

Properties.—A brittle, crystalline white metal, with a reddish tinge; sp. gr. 9.8; fuses at 507°, and burns at a higher temperature, giving rise to yellow fumes, which on cooling become the *white oxide*. Its proper solvent is nitric acid.

TEROXIDE, BiO_3, old; new, Bi_2O_3.—Obtained by heating the nitrate; feebly basic.

PEROXIDE, BiO_5, old; new, Bi_2O_5.—It is acid.

The CHLORIDE, $BiCl_3$, old; new, Bi_2Cl_6, is made by direct combination; also by dissolving the teroxide in hydrochloric acid. Thrown into water, it is decomposed into the insoluble white oxychloride, and hydrochloric acid. This precipitate, as well as the subnitrate, is sold under the name of *pearl white;* used as a cosmetic.

Nitrate, $BiO_3 3NO_5$, old; new, $Bi_2O_3,3(N_2O_5)$.—Made by the action of nitric acid on bismuth. When the nitrate is thrown into

water, the insoluble *subnitrate* (BiO_3NO_5, old; new, Bi_2O_3,N_2O_5) is precipitated, and the acid *supernitrate* remains dissolved. The commercial subnitrate sometimes contains arsenic.

The *subcarbonate* is made by the reaction of carbonate of sodium on the nitrate. Used in medicine.

The alloys of bismuth, lead, and tin melt easily, and expand on cooling; hence they are employed in taking casts. The *fusible metal*, thus made, liquefies below 212°.

Test.—The action of water on the *nitrate*.

Nickel. Symb. Ni. Eq. 29, old; new, 58.

This metal, with cobalt, generally occurs in arsenious ores.

Properties.—A white metal; sp. gr. 8.8; difficult of fusion; malleable; magnetic; occurs also in *meteorites*.

The PROTOXIDE, or *monoxide*, NiO, forms salts of a delicate green color.

There is also a peroxide, Ni_2O_3.

Nickel is chiefly used in the manufacture of German silver, an alloy of copper, zinc, and nickel.

Cobalt. Symb. Co. Eq. 30, old; new, 60.

A brittle, reddish-gray metal; magnetic; sp. gr. 8.5; slowly oxidizes in the air; its preparations much used as pigments.

PROTOXIDE, or *monoxide*, CoO.—Forms pink salts, but is precipitated by alkalies as a blue hydrate. It produces *cobaltous* salts; the *sesquioxide*, Co_2O_3, forms with acids *cobaltic* salts. The latter, with alkalies, give brown precipitates.

CHLORIDE, CoCl, old; new, $CoCl_2$.—Used in dilute solution as *sympathetic ink*; characters written with this fluid become invisible on being dried, but on heating, they become *blue*, from the water being drawn off.

Cobalt is much employed to give a blue color to glass; also in blowpipe analysis. *Zaffre* is an impure oxide of cobalt, mixed with sand; *smalt* is a glass colored blue by cobalt.

Uranium and Cerium.

These are very rare metals, and of no especial practical use. The former is employed to give a yellow color to glass. Oxalate of cerium is sometimes used in medicine.

Order II.—METALS WHOSE OXIDES FORM WEAK BASES, OR ACIDS.

This order includes Chromium, Tin, Arsenic, Antimony, Vanadium, Tungsten, Molybdenum, Columbium, Titanium, Tellurium, and Osmium.

Chromium. Symb. Cr. Eq. 26.1, old; new, 52.2.

Obtained from native *chromate of iron*. A dark gray metal, possessing a strong affinity for oxygen; sp. gr. 6.81. It forms several compounds with oxygen; the *protoxide* or *monoxide* is basic; the *sesquioxide* is a feeble base, forming green salts.

CHROMIC ACID, CrO_3, old; new system, $CrO_3.H_2O$, or CrO_4H_2; is

made by the action of sulphuric acid on bichromate of potassium in solution; the acid is precipitated in deep red crystals, which are very deliquescent, and easily decomposed into green sesquioxide, by contact with organic matter; a powerful oxidizing agent.

The most important salts are the *chromate* (yellow), and the *bichromate* (red) of potassium; and *chrome yellow* (the chromate of lead).

Test.—The color of its salts of lead, silver, and mercury.

Tin. Symb. Sn. Eq. 59, old; new, 118.

The native oxide, SnO_2, is called *tin stone.* It is extracted by roasting and reduction with charcoal.

Properties.—A brilliant, white, malleable metal; sp. gr. 7.29; fuses at 442°; emits a crackling noise when a bar is bent; burns brilliantly in the air at high temperatures, forming the *binoxide.* Much used for plating sheet iron, which is known as *sheet tin.* An amalgam of tin is employed for silvering mirrors.

PROTOXIDE, or *monoxide*, SnO.—Formed by adding an alkaline carbonate to protochloride; it falls as a white hydrate.

The *sesquioxide*, Sn_2O_3, has a grayish color.

PEROXIDE, SnO_3, new; old, SnO_4H_2 (*stannic acid*), may be obtained by precipitation from the perchloride; or by dilute nitric acid on metallic tin; this last variety has been denominated *metastannic acid*, as it differs in some points from the other.

CHLORIDE, SnCl, new; $SnCl_2$.—Made by dissolving tin in hot hydrochloric acid; it is used as a deoxidizing agent.

PERCHLORIDE, $SnCl_2$, old, new, $SnCl_4$ (*fuming liquor of Libavius*).—Made by the action of nitromuriatic acid on tin; a colorless fuming liquid; used as a *mordant* in dyeing.

There are three SULPHURETS.—Proto-, sesqui-, and bisulphide; the latter is known as *mosaic gold.*

Test.—Chloride of gold gives with the protochloride of tin a splendid purple color—the *purple of Cassius.*

Arsenic. Symb. As. Eq. 75.

The most common ores of arsenic are the native sulphides—orpiment and realgar. Found also alloyed with nickel, cobalt, iron, and copper. When these ores are roasted, the arsenic, being volatile, rises in vapor, and is condensed, as an oxide, in the flues. By heating this with charcoal, the metal is obtained.

Properties.—Very brittle, of a steel gray color; sp. gr. 5.8; vaporizes at 356°, giving off alliaceous fumes, and if air be present, it is converted into arsenious acid.

It forms two *acid* compounds with oxygen, but no base.

ARSENIOUS ACID, or *arsenious oxide*, AsO_3, old; As_2O_3, new (*white oxide of arsenic*).—Obtained by burning arsenic in the air. When first made, it is translucent and glassy, but becomes opaque when long kept; volatile at 380°; vapor inodorous; condenses in octahedral crystals, by which it may be always recognized. Not very soluble in water; very soluble in alkaline solutions; has a feeble acid reaction; forms *arsenites;* has a feeble, sweetish, rough taste; a violent poison.

Arsenic Acid, or *arsenic oxide*, AsO_5, old; As_2O_5, new.—Made by dissolving arsenious acid in strong nitric acid, and evaporating to dryness. It has a sour taste; quite soluble in water; is isomorphous with phosphoric acid; forms *arseniates*.

Bisulphide, AsS_2 (*native realgar*); on the new method, called *disulphide*, As_2S_2.—Made by heating together arsenious acid and sulphur. Color, ruby-red.

Tersulphide, AsS_3 (*native orpiment*), *sulph-arsenious acid;* new notation, trisulphide, AsS_3.—Made by the action of sulphuretted hydrogen on a solution of arsenious acid. Color, yellow; called *king's yellow.*

Pentasulphide (*sulph-arsenic acid*), AsS_5, old; new, As_2S_5.—Made by the action of sulphuretted hydrogen on arsenic acid. Color, yellow.

Arsenic unites with iodine, bromine, etc.

Arseniuretted Hydrogen, AsH_3.—Prepared by adding arsenious acid to the materials for generating hydrogen. It is a colorless gas; of an alliaceous odor; excessively poisonous; burning with a bluish flame, and generating arsenious acid and water.

Tests.—1. *Ammoniacal nitrate of silver* gives with arsenious acid a yellow arsenite of silver. 2. *Ammonio-sulphate of copper* gives the light green arsenite of copper (*Scheele's green*). 3. *Sulphuretted hydrogen*, in an acid solution of arsenious acid, throws down the *yellow* sulphide. 4. The production of arseniuretted hydrogen, by using Marsh's apparatus, and allowing the burning jet to impinge on a cold white porcelain surface; the brownish-black spot is deposited (or by heating the glass tube through which the gas is passing, the characteristic *ring* is deposited on the tube just in advance of the heated portion). 5. Reducing the arsenious acid, or the dried sulphide, in a glass reduction tube, so as to procure the *arsenical ring.* 6. (Reinsch's) Tarnishing bright copper wire, when heated after acidulation with hydrochloric acid.

The proper *antidote* for arsenic is *hydrated peroxide of iron, in the moist state.*

Antimony. Symb. Sb. Eq. 122.

Occurs in nature chiefly as the *sulphide*, which is known commercially as *crude antimony;* whilst the pure metal is known as the *regulus of antimony.* From the sulphide it may be procured by heating with iron filings.

Properties.—A crystalline brittle metal of a bluish-white color, metallic lustre; sp. gr. 6.8; at a high temperature burns in the open air, the vapor condensing in white crystals of the peroxide (*argentine flowers of antimony*). Both nitric and muriatic acids act upon it. It forms three compounds with oxygen.

Teroxide, SbO_3, old; new, Sb_2O_3.—Obtained by burning antimony in the open air; as a hydrate, by precipitation from a solution of tartar emetic by means of an alkaline carbonate. It has a pale yellow color; the basis of all the antimonial salts.

Antimonious Acid, SbO_4, old; new, Sb_2O_4.—Made by heating the oxide in open vessels. It is a grayish-white powder, insoluble; combines with bases.

Antimonic Acid, SbO_5, old; new, Sb_2O_5.—Made by the action

of strong nitric acid on antimony; an insoluble straw-colored powder; unites with bases, forming *antimoniates*.

TERCHLORIDE, or *trichloride* (*butter of antimony*), $SbCl_3$.—Made by burning antimony in chlorine gas; also by the action of boiling hydrochloric acid on the sulphide. When thrown into water, it is decomposed; hydrochloric acid and the teroxide are generated; the latter, combining with some undecomposed chloride, forms the *oxychloride*, or *powder of Algaroth*. There are two other chlorides.

TERSULPHIDE, or *trisulphide*, SbS_3, old; Sb_2S_3, new.—The native black sulphide; made by action of sulphuretted hydrogen on tartar emetic. There is also a *pentasulphide*.

Kermes Mineral.—An *oxysulphide*;—prepared by boiling together tersulphide of antimony in a solution of potassa or its carbonate. A partial decomposition ensues, by which an oxide of antimony and sulphide of potassium are formed; the latter unites with some undecomposed sulphide of antimony to form a sulphur salt (sulph-antimoniate of potassium). As the solution cools, this salt decomposes; the tersulphide of antimony subsiding, along with a variable portion of potassa and oxide of antimony. This is the *kermes* On the addition of sulphuric acid to the mother-water, more of the teroxide and tersulphide are precipitated together, constituting the *golden sulphuret*.

Tartar emetic (*tartrate of antimony and potassa*), $KO,SbO_3,\overline{T}$; new formula, $KSbC_4H_4O_7,H_2O$.—The most important of all the antimonial salts. Made by boiling cream of tartar with teroxide of antimony. It is a white crystalline salt, soluble in water; of a styptic taste; yielding precipitates with the mineral acids, the alkalies, earths, and tannin; also with sulphuretted hydrogen.

Tests.—Sulphuretted hydrogen gives the orange-colored tersulphide; the action of water on the terchloride.

The remaining metals of this order are of but little practical importance, and demand no further attention here.

Order III.—METALS WHOSE OXIDES ARE REDUCED BY HEAT.

Mercury. Symb. Hg. Eq. 100, old; new, 200.

Occasionally found in the metallic state, but more frequently as a sulphide (*cinnabar*) and chloride. Extracted from its ores by sublimation.

Properties.—The only metal fluid at common temperatures; solidifies at —39° F.; has a bluish-white color; strong metallic lustre; sp. gr. 13.6; boils at 662° F.: gives off vapor at ordinary temperature; when pure, is not acted upon by the air; when boiled in the air it absorbs oxygen; boiling sulphuric acid converts it into the sulphate; nitric acid, hot or cold, acts upon it, forming nitrates. When solidified, it is malleable.

Mercury forms two oxides, chlorides, iodides, and sulphides.

SUBOXIDE (*black oxide*), Hg_2O.—Made by the action of an alkali on a subsalt—as lime-water on calomel (*black wash*). It is a dull gray powder, insoluble in water; decomposed by light into the red oxide and metallic mercury.

PROTOXIDE, or *monoxide* (*red oxide*), HgO.—Made by the action

of an alkali on a protosalt—as lime-water on corrosive sublimate (*yellow wash*); also, by heating the metal in the open air; also, by heating the nitrate; often called *red precipitate*. It is in fine red shining scales; very slightly soluble in water; converted by high heat into oxygen and mercury.

SUBCHLORIDE, or *mercurous chloride* (*calomel*), Hg_2Cl, old; new, Hg_2Cl_2.—Prepared either by *precipitation* from the subnitrate by common salt; or by *sublimation* of the protosulphate with metallic mercury and common salt, thus, according to the old notation, $HgO,SO_3+Hg+NaCl=Hg_2Cl+NaO,SO_3$. On the new system, the reaction is stated as follows: $HgSO_4+Hg+2NaCl=Hg_2Cl_2+Na_2SO_4$.

Calomel sometimes occurs native; as prepared by sublimation it is in yellowish-white masses, very heavy; sp. gr. 7.2; insoluble and tasteless; is apt to contain a trace of corrosive sublimate, from which it is separated by washing in water. Potassa or lime decomposes it, throwing down the black oxide.

PROTOCHLORIDE, or *mercuric chloride* (*corrosive sublimate*), $HgCl$, old; new, $HgCl_2$.—Prepared by burning mercury in chlorine gas; by the action of hydrochloric acid on the red oxide; and preferably, by subliming together the protosulphate and common salt, thus, on the old method, $HgOSO_3+NaCl=HgCl+NaOSO_3$. The new formula for this reaction is $HgSO_4+2NaCl=HgCl_2+Na_2SO_4$.

It is crystalline; soluble in water, alcohol, and ether; has an austere metallic taste; the alkalies decompose it, precipitating the red oxide; ammonia throws down the *white precipitate*. It is a violent poison, for which the best antidote is *albumen*.

There are two iodides, the *green* and the *red;* two bromides; one cyanide; and two sulphides. The *sulphide* occurs native as *cinnabar;* its powder is named *vermilion*. *Ethiops mineral*, made by triturating together mercury and sulphur, is considered to be a mixture of the protosulphide and sulphur.

The most important salts of mercury are the nitrates and sulphates, of both the oxides. The *turpeth mineral* is a subsulphate, made by throwing the sulphate into water; it subsides as a yellow insoluble powder.

Tests.—Iodide of potassium gives with a protosalt a fine red-colored precipitate; with a subsalt, a greenish one; the alkalies throw down from a protosalt a yellowish-red precipitate—the red oxide; with a subsalt, a black precipitate; protochloride of tin yields a black precipitate, if heated with a subsalt; a drop of a mercurial solution placed upon a piece of bright copper or gold, and touched with a pointed steel, deposits a white stain.

Gold. Symb. Au. Eq. 197.

Always occurs pure, either in grains or masses, or disseminated through quartzose rock, or in union with silver and copper; usually separated from impurities by amalgamation with mercury, which is afterwards driven off by heat. From silver it is separated by the process of *quartation*, which consists in adding to the alloy so much silver as to make the latter constitute three-fourths of the mass; in which case the whole of the silver can be separated by

nitric acid. May be obtained pure by dissolving in aqua regia, and precipitating by a protosalt of iron.

Properties.—Has the well-known yellow color; soft, very malleable and ductile; is not tarnished by air or moisture; sp. gr. 19.3. The proper solvent is *aqua regia;* an ethereal solution, made by agitating this in ether, is employed for gilding. It forms compounds with oxygen, sulphur, chlorine, and iodine, which, however, are of no practical importance. Gold coins are alloyed with copper or silver, which increases their hardness.

Test.—Protochloride of tin gives with the solution of gold the *purple* of *Cassius*, which is used in enamel painting and staining of glass.

Silver. Symb. Ag. Eq. 108.

Is found native; also as a chloride, sulphide, and iodide; also in argentiferous galena. Extracted by *amalgamation* and *cupellation*—the latter process being only applicable to its combinations with lead. Pure silver can be obtained from silver coins by dissolving in nitric acid, precipitating with muriatic acid, or common salt, and treating the resulting chloride with carbonate of sodium.

Properties.—A white brilliant metal; sp. gr. 10.5; very malleable and ductile; the best conductor of heat and electricity; is not acted upon by air or moisture, unless sulphur be present, when it is blackened; its proper solvent is nitric acid. It forms two or three oxides, of which the protoxide is basic.

The most important salt is the *nitrate*, AgO,NO_5, old system; new, $AgNO_3$; made by dissolving silver in nitric acid, and crystallizing. It is very soluble in water; the solution when in contact with organic matter, and exposed to the light, becomes darkened, probably from the reduction of the metal or the formation of an oxide: this is the basis of *photography*. When the nitrate is fused into sticks, it constitutes *lunar caustic*.

Silver forms compounds with chlorine, iodine, and sulphur.

The *arbor Dianæ* is made by suspending mercury in a solution of silver nitrate; the silver is precipitated in the form of beautiful arborescent crystals.

Test.—Chlorine, in the form of hydrochloric acid, or a soluble chloride, throws down a white curdy *chloride*, which speedily darkens on exposure to light, and is insoluble in nitric acid, but very soluble in ammonia.

Platinum. Symb. Pt. Eq. 98.7, old; new, 197.4.

Occurs in metallic grains, associated with palladium, osmium, rhodium, and iridium, metals of the same group. The native grains may be fused into bars by the intense heat of the oxy-hydrogen blowpipe; or it may be precipitated pure from its solution in aqua regia, by chloride of ammonium, in the form of a double chloride, which, on exposure to heat, leaves the metal in a finely divided state, constituting *platinum sponge;* this may be condensed by great pressure.

Properties.—A whitish metal; except osmium, the heaviest body known; sp. gr. 21.15; soft; can be welded like iron; is not

acted upon by air, moisture, the strongest acids, or by the highest heat of a smith's forge; hence it is admirably adapted for crucibles, retorts, etc., in the laboratory. It can only be fused by galvanic agency, or by the compound blowpipe. Its proper solvent is nitromuriatic acid (*aqua regia*). In its habitudes with oxygen, sulphur, chlorine, etc., it resembles gold.

Platinum-sponge and *platinum-black* possess the singular property of causing a mixture of hydrogen and oxygen gases to unite with explosive violence, producing combustion. This is probably owing to the gases being so powerfully condensed in the pores of the metal, as to bring them within the sphere of their mutual chemical attraction.

The most important compound of platinum—the *bichloride*, or *platinic chloride*, $PtCl_2$, old method, $PtCl_4$, new—is used as a test for potassa, and as a source for procuring its other preparations.

Test.—A solution of chloride of potassium forms with it the double chloride of platinum and potassium, of a yellow color.

The other metals of this order—*Palladium*, *Osmium*, *Rhodium*, and *Iridium*—require here no particular description. Osmium is the heaviest of metals.

PART III.

ORGANIC CHEMISTRY.

PRELIMINARY OBSERVATIONS.

ORGANIC CHEMISTRY treats of *organized* bodies, or such as are the product of the vital force; and also of *organic* compounds, or those which are derived from the former by chemical agencies.

Organic substances, whether of animal or vegetable origin, differ from the inorganic in many particulars. They are chiefly remarkable for the complexity of their composition, but, at the same time, for the limited number of their elements. Only four elements—carbon, hydrogen, oxygen, and nitrogen—are considered as *essential* to the composition of organic matter; though others are frequently met with, chiefly sulphur and phosphorus, and also chlorine, potassium, sodium, etc.; altogether, they do not amount to more than twenty. There appears, however, to be no limit to the number of definite compounds that may be formed out of the few elements above mentioned, simply by a change in their proportion and the mode of their arrangement.

In consequence of the complexity of organic bodies, they are generally very unstable, being prone to decomposition whenever the restraining force is removed. The most common products of organic decomposition are water, carbonic acid, and ammonia; and if sulphur and phosphorus be present, sulphuretted and phosphoretted hydrogen.

Generally, the liability to decomposition is in direct proportion to the complexity of composition; but this tendency is much lessened if the elements are in such proportion as completely to saturate each other; thus, in sugar, starch, and lignin, the proportions of oxygen and hydrogen are just those to form water; consequently, these are not very unstable compounds.

Whilst inorganic bodies are often *binary* in their composition, organic substances are usually *ternary* (vegetable), or *quaternary* (animal); and sometimes *quinternary*, or even higher.

All organic bodies are decomposed by heat.

Isomerism is often met with in organic bodies. By this is meant a similarity of chemical composition, with a difference of properties: thus, starch, sugar, and lignin, on analysis, exhibit almost precisely the same composition, although so very diverse in their properties. Isomerism is believed to depend upon a *different arrangement* of the constituent atoms of the body, their *kind* and *number* remaining the same.

In organic bodies, one element may frequently be *substituted* for another, without altering the essential characters of the compound.

Analysis of organic bodies.—Organic substances contain carbon in excess of the quantity of oxygen necessary to consume it; hence, in being heated in a close vessel the carbon remains as a black mass: this is characteristic of organic matter. Water may be driven off at a heat of 212°. Mineral matters are determined by burning the substance in a crucible, and examining the ash. The different *proximate principles* contained in organic bodies—such as sugar, gum, resin, starch, albumen, gelatin, etc., can be separated by the various menstrua—water, alcohol, ether, etc. Fractional distillation is also employed to separate bodies of different degrees of volatility.

The *ultimate analysis* of organic bodies is effected by burning the body, and weighing the products of decomposition. This is accomplished by the method of Liebig, which consists in first drying and accurately weighing the organic substance, then mixing it with an excess of the black oxide of copper, and placing the whole in a *combustion-tube*—a tube of hard Bohemian glass drawn out to a fine point, which is closed. Heat is now gradually applied, and the products of combustion are made to pass through a second tube containing dried chloride of calcium, which is previously weighed; this absorbs all the water (the result of the union of the hydrogen of the organic body with the oxygen of the oxide of copper); one-ninth of this gain of course represents the whole amount of *hydrogen*. An arrangement of glass bulbs, containing a solution of potassa, receives the carbonic acid (the result of the union of the carbon of the organic body with oxygen); three-elevenths of which gain represents the amount of *carbon*. The *oxygen* is estimated by subtracting the combined weights of the carbon and hydrogen from the whole weight of the organic body. If the organic body contains *nitrogen*, an alkali must be added to convert it into ammonia, which is afterwards estimated as chloride of ammonium.

Sulphur is estimated by burning it into sulphurous oxide, then oxidizing by nitric acid into sulphuric acid, precipitating this by

baryta; from the sulphate of which, the amount of sulphur can be calculated.

Phosphorus may be converted into a phosphate, and thence calculated.

In organic analysis the utmost precision is required in the processes of drying and weighing.

Theoretical Arrangement.—The ultimate analysis of an organic body gives us merely a knowledge of the number and kind of elements composing it. It does not indicate the *mode of arrangement* of these elements; they may be grouped together in a variety of modes, theoretically. The formula given by ultimate analysis is termed the empirical formula; that which represents the supposed arrangement, the *rational* formula.

Compound Radicals.—A compound radical is a body which, although containing two or more elements, acts precisely like a single elementary body. *Cyanogen*, C_2N, old; C_2N_2, or CN, new system, is an example. They are very numerous. By far the larger number contain only carbon and hydrogen, the equivalents of the former being even, those of the latter, odd. They form oxides, hydrates, and compounds with the acids and halogens, strictly analogous to the corresponding compounds of the metals. Thus, according to the old system, ethyl (C_4H_5, old, C_2H_5, new) forms the oxide (*ether*) C_4H_5O, old, $C_4H_{10}O$, new; also the hydrated oxide (*alcohol*) C_4H_5O,HO, old, C_2H_6O, new; nitrate (*nitrous ether*); chloride (*hydrochloric ether*), etc. etc. Although this is a convenient theory, it must not be forgotten that it is altogether assumed.

Substitution Compounds.—In inorganic chemistry, hydrogen is replaced by the metals, and the amphigens and halogens replace each other. In organic chemistry, this substitution process takes place much more extensively; the most remarkable bodies of this group will be found under the head of the *Substitution Ammonias.*

CHAPTER I.

THE AMYLACEOUS OR STARCH GROUP, WITH THEIR DERIVATIVES.

THIS class embraces Starch, Gum, Sugar, Dextrin, Cellulose, and Pectin. They contain hydrogen and oxygen in the proportion to form water. By Prout they were denominated *hydrates of carbon*, or *carbohydrates*.

Starch.

STARCH OR FECULA, $C_{24}H_{20}O_{20}$, old system; new, $C_6H_{10}O_5$, or $C_{18}H_{30}O_{15}$.—A very abundant proximate principle; existing in the roots, seeds, and stems of vegetables, in the form of granules, which vary very much in size. Prepared by mechanically washing flour or potatoes by a stream of water, which carries off the starch, and subsequently deposits it on standing.

Properties.—A white, shining powder; insoluble in alcohol and cold water; appears to be a homogeneous substance, but under the microscope is found to consist of granules surrounded by a thin envelope. When boiled, this envelope bursts open, liberating the contents, which form with the water a gelatinous paste (*clear-starch, amidon*); this is, probably, not a true solution.

The size of the starch-granules varies greatly, depending on the source from which they are derived; those of the *canna* and potato are the largest. Arrowroot, sago, and tapioca are examples of pure starch.

In the process of germination of seeds, and the fermentation of malt, the starchy matter of the grain is converted into a sweetish gummy matter, termed *dextrin*, and ultimately into *grape-sugar*. The causation of this remarkable change is due to a peculiar principle found in the grain at that period, named *diastase*, which acts as a sort of ferment.

Dilute acids (except phosphoric), diastase, and saliva convert starch into dextrin and grape-sugar; cold strong nitric acid converts it into *xyloidin;* hot nitric acid oxidizes it into *oxalic acid.* The proper *test* for starch is *iodine*, which gives to it a characteristic blue color.

DEXTRIN has the same composition as starch. It is made by the action of diastase or the saliva in starch; also by boiling starch in dilute sulphuric acid. It is also prepared as *British gum*, by roasting starch at a temperature of 400°. It has a sweetish taste; does not ferment; it is very adhesive.

Gum.

$C_{24}H_{22}O_{22}$, old; new, $C_{12}H_{22}O_{11}$ (arabin).—A proximate principle which exudes spontaneously from various trees. Distinguished from *resin* by being soluble in water and insoluble in alcohol, also by the action of nitric acid, which converts it into *mucic acid.*

Guerin divides gums into three classes: 1. *Arabin* (of which gum Arabic is the type), perfectly soluble in cold water; 2. *Bassorin*, $C_{24}H_{20}O_{20}$, old; new, $C_{12}H_{20}O_{10}$ (of which gum tragacanth is the type), swells up into a jelly, or paste, with water, but does not dissolve; 3. *Cerasin*, found in cherry-tree gum; insoluble in cold, but soluble in hot water; believed to be a mixture of the two former. The *mucilage* of gum Arabic differs somewhat from the mucilage of flaxseed; the former is precipitated by subacetate of lead; the latter, by the neutral acetate.

Pectin, the gelatinizing principle of fruits, is closely allied to gum. In the unripe fruit, *pectose*, a substance insoluble in water, alcohol, or ether is found; during ripening, this is converted into pectin, by a species of fermentation. It forms *pectic acid.*

Sugar.

Exists in various saccharine natural juices, as of the *sugar-cane, beet, maple*, etc. There are several varieties of sugar.

Cane-sugar, $C_{24}H_{22}O_{22}$, old; new, $C_{12}H_{22}O_{11}$.—Prepared from the juice of the sugar-cane by boiling and evaporating; this constitutes *raw* or *common brown sugar.* It is refined by dissolving in water,

and removing the impurities by means of coagulating albumen. The uncrystallizable portion is named *molasses.* Strong sulphuric acid chars it; dilute acids convert it into grape-sugar. It combines with alkalies, forming salts; heated above 378° it loses water, and is converted into *caramel*, which is used for coloring liquids and syrups. Strong nitric acid forms with it *oxalic acid.*

Grape-sugar (glucose), $C_{24}H_{28}O_{28}$, old; new, $C_6H_{12}O_6$, forms the white crystals on the outside of candied fruits. It exists normally in the liver; abnormally in the urine, in diabetes. It is easily formed by the action of dilute sulphuric acid on cane-sugar, starch, gum, etc. It differs from cane-sugar in several particulars: it is less sweet, less soluble, and does not form regular crystals. Strong mineral acids affect it; sulphuric acid converts it into *sulphosaccharic acid;* nitric acid into *oxalic acid.* With the alkalies it forms salts.

Test.—Grape-sugar (as in diabetes) may be distinguished by adding to the solution a few drops of the solution of *sulphate of copper*, and then some *liquor potassæ*, and boiling; the production of the *red oxide* of copper, which precipitates, is conclusive of its presence.

This is the only sugar capable of undergoing the vinous fermentation; the others being first transformed into this.

Fruit-sugar, $C_{24}H_{24}O_{24}$, old; new, $C_6H_{12}O_6$.—Is found in the juices of ripe acid and subacid fruits. Is frequently associated in these with cane-sugar, into which it is converted by the action of dilute acids and diastase. It is sweet, soluble, and uncrystallizable, and readily passes into grape-sugar. Fruit-sugar consists of glucose with *levulose;* a saccharine matter whose solution rotates the ray of polarized light to the left. Glucose and sucrose (cane-sugar) rotate it to the right.

Milk-sugar (lactin), $C_{24}H_{22}O_{22}$, old; new, $C_{12}H_{22}O_{11}$.—This is the sweet principle of milk; procured by evaporating whey. It is in hard, gritty crystals, soluble in seven parts of cold water, insoluble in alcohol and ether; is converted into glucose by dilute acids (nitric acid converts it into *mucic acid*). It readily undergoes the *lactic fermentation.*

There is a number of *false sugars* (not undergoing the vinous fermentation), such as *mannite*, the sweet principle of manna; *glycyrrhizin*, from liquorice; *glycocoll*, the sweet principle of gelatin, etc.

Cellulose.

$C_{24}H_{20}O_{20}$, old; new, $C_6H_{10}O_5$.—Constitutes the basis of wood, and all vegetable structure. A thin slice of wood, viewed microscopically, is seen to consist of a true cellular structure, incrusted with various matters. Cellulose, from whatever source obtained, is identical in *chemical* composition, however varied it may be in *physical* appearance; thus, it is loose, spongy, and digestible, in succulent roots, as the turnip and potato; porous and elastic, in the pith of the rush and alder; flexible and tenacious in the fibres of hemp and flax; compact in the wood of trees; and very hard and dense in the shells of nuts. It is found nearly pure in carded cotton, linen, and the finest unsized paper.

Properties.—A white, tasteless substance, insoluble in water, alcohol, ether, or oils ; may be dissolved in the cold, in a solution of ammonio-sulphate of copper. Cold sulphuric acid converts it first into dextrin, and then into grape-sugar. Nitric acid, or still better, equal measures of strong nitric and sulphuric acids, convert it in a few moments into *pyroxylin*, or *gun-cotton*. The chemical change produced consists in the abstraction of hydrogen and the substitution of an equal number of equivalents of peroxide of nitrogen. A less explosive variety is made by the action of sulphuric acid and nitrate of potassium on cotton. This variety is soluble in ether ; such a solution is termed *collodion*, and is much used as a liquid adhesive plaster.

Xyloidin.—An explosive compound resembling pyroxylin ; is made by the action of nitric acid on paper, starch, sugar, etc.

A peculiar substance named *vegetable parchment* is made by plunging unsized paper for a few moments into a mixture of oil of vitriol with half its bulk of water ; the paper must be quickly withdrawn and washed with water and weak ammonia.

Lignin is the incrusting matter contained within the cellulose. In composition it somewhat differs from the latter, containing a larger quantity of hydrogen. It does not appear to have a uniform composition in all woods. It is soluble in strong alkalies, by means of which it may be separated from cellulose. The ligneous matter is generally deposited mixed with a variable quantity of resinous matters, which color the wood, and increase its inflammability.

Sclerogen is present in the hardest wood, and in the shells of nuts, stones of fruits, etc.

When wood is kept in dry air, or wholly submerged under water, it undergoes no change ; but exposed to moist air, it slowly undergoes decay (*eremacausis*) by absorbing oxygen, and giving out carbonic acid and water. This may be prevented by certain antiseptics, which coagulate the albuminous matter ; the best are chloride of zinc, corrosive sublimate, sulphate of copper, and coal tar. The fertility of soils depends greatly upon the *vegetable mould* resulting from decaying vegetable matter ; this contains *humus*, *humic acid*, *ulmin*, and *ulmic acid*, etc.

Vegetable matter undergoing decomposition *partially* excluded from the air (as the roots and branches of plants under water, or ground, or in marshes), is converted into *peat*, and gradually into *lignite* and *coal*.

By destructive distillation of wood, a variety of complex products results : these may be classed as (1), *Gases*, carbonic oxide and acid, light and heavy carburetted hydrogen, ammonia, and cyanogen, together with other hydrocarbons, among which is a solid *naphthalin*. (2). *Tar*, a very complex body, containing wood-spirit, acetic acid, paraffin, and creasote. The two former will be considered subsequently. *Paraffin* is a beautiful transparent solid, used in the manufacture of candles. *Creasote* is, when pure, a colorless oily liquid, of a burning, caustic taste, and peculiar smell ; inflammable ; boils at 397° ; coagulates albumen ; is antiseptic, and is believed to be the preservative principle in wood-smoke.

Carbolic or *Phenic Acid.*—Obtained from *coal-tar*, is very analogous to creasote in its properties. It is in transparent crystals,

very deliquescent, and soluble in water; much employed as a disinfectant and antiseptic.

By the distillation of coal, products are obtained equal in number and variety to those procured from wood. Among them the most important are *naphtha* and *coal oil*. The latter yields, by treatment with acids and alkalies, several compounds; among which are the *aniline* and other dyes, and certain fragrant substances.

Fermentation.

By this is understood a certain decomposition produced in organic bodies, through the agency of *ferments*, which are decomposing nitrogenized substances. The molecular movement which is taking place in the ferment, seems to be communicated to the fermentable substance, causing it to be broken up into simpler constituents A very small portion of a ferment is sufficient to start the process. There are various ferments, as *yeast* (the frothy matter that forms on beer and other liquids during fermentation), blood, casein, albumen, etc., all of which contain nitrogen.

The *conditions* of fermentation are: (1), contact with the ferment; (2), access of the air, though this is not essential after the process has begun; (3), a proper temperature; a boiling or freezing temperature completely arrests it; antiseptics also prevent it. The atmosphere always contains organic germs or spores which appear to be capable of inducing fermentation.

The varieties of fermentation are, the *vinous*, *acetic*, *lactic*, *butyric*, and *viscous*.

Vinous Fermentation.—This is the fermentation resulting in the production of *vinous* liquors and alcohol. The conditions for it are: a solution of sugar, a proper temperature—about 70°—the presence of a ferment, and exposure to the air. The only true fermentable sugars are grape and fruit-sugar, the others being converted into these by chemical agency. During this fermentation the following changes occur: an internal movement is set up, bubbles of gas escape, the liquid becomes turbid, but after a while it clarifies; the sugar is found to have disappeared, and the liquid acquires an alcoholic taste. The *chemical* change produced is the conversion of sugar into alcohol, carbonic acid, and water; according to the old system, stated thus:—

$$\left.\begin{matrix}\text{1 grape sugar}\\ C_{24}H_{28}O_{28}\end{matrix}\right\} = \left\{\begin{matrix}\text{8 carb. acid}\\ 8CO_2\end{matrix}\right\} + \left\{\begin{matrix}\text{4 alcohol}\\ 4(C_4H_6O_2)\end{matrix}\right\} + \left\{\begin{matrix}\text{4 water}\\ 4HO\end{matrix}\right.$$

$$\text{or,}\quad \left.\begin{matrix}\text{1 fruit sugar}\\ C_{24}H_{24}O_{24}\end{matrix}\right\} = \left\{\begin{matrix}\text{8 carb. acid}\\ 8CO_2\end{matrix}\right\} + \left\{\begin{matrix}\text{4 alcohol}\\ 4(C_4H_6O_2)\end{matrix}\right.$$

Under the new method, the following formula is given:—

$$\left.\begin{matrix}\text{1 grape sugar}\\ C_6H_{12}O_6\end{matrix}\right\} = \left\{\begin{matrix}\text{2 alcohol}\\ 2C_2H_6O\end{matrix}\right\} + \left\{\begin{matrix}\text{2 carb. acid}\\ 2CO_2\end{matrix}\right.$$

The various kinds of *fermented* liquors, such as wine, cider, beer, etc., are made from the juices of the grape and other fruits, or from infusions of grain. These all contain sugar and a fermenting principle, and hence will undergo the vinous fermentation if exposed to a proper temperature with access of air. The amount of alcohol

contained in fermented liquors varies from three to more than twenty per cent. By distilling the fermented liquors, the different *spirituous* liquors, or *ardent spirits*, are procured. These contain about fifty per cent. of alcohol ; and by a second distillation they yield *rectified spirits* or *commercial alcohol*, which has a sp. gr. of .835, and which still contains fifteen per cent. of water. Pure or *absolute* alcohol can only be obtained by mixing the former with quicklime or chloride of calcium, and redistilling.

Properties.—Absolute alcohol is colorless and limpid, of a pungent taste ; sp. gr. .794 ; inflammable, burning with a pale bluish flame, and yielding carbonic acid and water ; boils at 173° ; has never been frozen ; unites with water in all proportions, also with ether ; has powerful solvent properties.

The process of *bread-baking* is an instance of vinous fermentation ; the yeast added to the dough converting a portion of its sugar into alcohol and carbonic acid. The gas thus liberated forces the tough and adhesive mass into bubbles ; these still further expand by the heat of the oven, which, at the same time, dissipates the alcohol.

Acetous Fermentation.—The process by which alcohol is converted into vinegar (acetic acid). The conditions are, a weak alcoholic solution, the presence of a ferment, and contact with the air ; oxygen is absorbed. This change will be more fully studied under ACETIC ACID.

Lactic Fermentation.—The process by which sugar of milk is converted into lactic acid. The ferment here is the casein of the milk. Some alcohol is formed at the same time. This change occurs spontaneously in milk, if allowed to stand for some time, and is the cause of its souring. Simultaneously with its production, the coagulation of the milk takes place, in consequence of the acid combining with the soda and thus precipitating the casein.

Lactic acid has an intensely sour taste and acid reaction. It is also produced from sugar, by mixing it with putrid cheese and water, together with chalk ; lactate of lime is formed, which is decomposed by sulphuric acid. It exists normally in the gastric juice, and the juice of flesh.

Butyric Fermentation.—By continuing the above process another fermentation—the butyric, sets in. *Butyric acid* exists in rancid butter, putrid flesh, sweat, etc. It is an offensive, inflammable liquid, boiling at 157°. *Butyric ether*, when diluted, has the odor of pineapples, and is used for flavoring.

Viscous Fermentation.—This change occurs in the sugar of beets at a temperature of about 100° ; but little alcohol is formed, the product being a ropy or gummy matter. Sugar, to a certain extent, undergoes this change when yielding lactic and butyric acids. The ropiness of wines and beers affords illustrations of it.

Theories of Fermentation.—Berzelius ascribed it to *catalysis* or the "action of presence." Liebig supposed that the change taking place in the molecules of the ferment is communicated to those of the fermentable body. Others attribute it to the action of microscopic vegetable and animal germs, or sporules. Pasteur's idea is that neither fermentation nor putrefaction ever occurs without the presence of low organisms, of which multitudes exist in the

air and in water, known as *mycoderms*, *torulas*, *vibrios*, *monads*, etc. Each variety of fermentation has an organism peculiar to itself; thus the *mycoderma vini* causes sugar to break up into alcohol and carbonic acid; another mycoderm seems to convert alcohol into acetic acid; others again cause the transformation of sugar into lactic and butyric acid. Some of these organisms require oxygen for their activity, while others act without it. All the phenomena are arrested by a temperature over 130°, or below 50°; also by the action of antiseptics, as sulphurous acid, the sulphites, carbolic acid, etc.

CHAPTER II.

THE ALCOHOLS, AND THEIR DERIVATIVES.

COMPOUND radicals, homologous in their character, are the bases of all alcohols and ethers. According to the old chemistry, the oxide of the radical is named its *ether;* its hydrated oxide is called its *alcohol.* Generally speaking, both the radical and its compounds are obtained from their alcohols, which act with acids and halogens like hydrated metallic oxides.

The following are the most important members of the series. Old system :—

Name.	Radical.	Ether.	Alcohol.
Methyl,	C_2H_3	C_2H_3O	$C_2H_3O,HO.$
Ethyl,	C_4H_5	C_4H_5O	$C_4H_5O,HO.$
Propyl,	C_6H_7	C_6H_7O	$C_6H_7O,HO.$
Butyl,	C_8H_9	C_8H_9O	$C_8H_9O,HO.$
Amyl,	$C_{10}H_{11}$	$C_{10}H_{11}O$	$C_{10}H_{11}O,HO.$

New system :—

Name.	Radical.	Ether.	Alcohol.
Methyl,	CH_3	C_2H_6O	$CH_4O.$
Ethyl,	C_2H_5	$C_4H_{10}O$	$C_2H_6O.$
Propyl,	C_3H_7	$C_6H_{14}O$	$C_3H_8O.$
Butyl,	C_4H_9	$C_8H_{18}O$	$C_4H_{10}O.$
Amyl,	C_5H_{11}	$C_{10}H_{22}O$	$C_5H_{12}O.$

The term *alcohol* was originally applied to the volatile inflammable spirit resulting from vinous fermentations: but it has since been made generic, and is now employed to designate a very large class of products, some of which are homologous with ordinary alcohol, and others not. They vary materially in their physical characters, from common alcohol or wood spirit, which are liquids lighter than water, to some of the higher series (the *cetylic*, *cerylic*, and *melissylic*), which are solid, and resemble fats in appearance. The alcohols by imperfect oxidation yield *aldehydes;* and these by a further absorption of oxygen yield *acids.* Both the aldehydes

and acids may be regarded as *oxides of new radicals* (termed *negative radicals*).

A table of some of these is here given.

Old system :—

Radical.	Acid.
Formyl, $C_2\,H$	$C_2\,H\,O_3,HO$ Formic.
Acetyl, $C_4\,H_3$	$C_4\,H_3O_3,HO$ Acetic.
Allyl, $C_6\,H_5$	$C_6\,H_5O_3,HO$ Propionic.
Butyryl, $C_8\,H_7$	$C_8\,H_7O_3,HO$ Butyric.
Valeryl, $C_{10}H_9$	$C_{10}H_9O_3,HO$ Valerianic.

New system :—

Radical.	Acid.
Formyl, $C\,H$	$C\,H_2\,O_2$ Formic.
Acetyl, C_2H	$C_2H_4\,O_2$ Acetic.
Allyl, C_3H	$C_3H_6\,O_2$ Propionic.
Butyryl, C_4H	$C_4H_8\,O_2$ Butyric.
Valeryl, C_5H	$C_5H_{10}O_2$ Valerianic.

To illustrate the connection between the above two sets of bodies, according to the old system, we may take the ethyl series as an example: ethylic alcohol, C_4H_5O,HO, by losing water becomes C_4H_5O, *ether;* this, by the action of iodide of phosphorus, and subsequently of zinc, becomes C_4H_5, *ethyl*. This same alcohol, by dehydrogenation (partial oxidation), becomes C_4H_3O,HO, *aldehyde* (new system, C_2H_4O); and finally, by further oxidation, $C_4H_3O_3,HO$, *acetic acid* (new system, $C_2H_4O_2$).

All the alcohols, above named, have been isolated: the aldehydes are not yet complete: the list of acids might be continued uninterruptedly up to $C_{36}H_{35}O_3.HO$, *stearic acid;* and, with interruptions, to $C_{60}H_{59}O,HO$, *mellitic acid* (old notation). These latter are known as the *fat acids*. Only the most important members of the series can be here considered.

Methylic Alcohol (Wood Spirit), C_2H_3O,HO, old; new, CH_4O.—One of the products of the destructive distillation of wood. A colorless, inflammable, limpid liquid; sp. gr. .798, boils at 152°; has a pungent odor and taste; miscible with alcohol and water. It may, generally, be used as a substitute for common alcohol.

Formic Acid, C_2HO_3,HO, old; new, CH_2O_2.—The natural derivative from methylic alcohol by dehydrogenation. Exists in ants, caterpillars, sweat, etc. May be formed by the direct oxidation of wood spirit by platinum black; also by distilling red ants in water. It resembles its homologue, glacial acetic acid; corrosive; blisters the skin; sp. gr. 1.235; boils at 209°.

Chloroform, C_2HCl_3, old; new, $CHCl_3$.—The *terchloride of formyl;* or formic acid in which (old method) O_3 has been replaced by Cl_3. Made by distilling chloride of lime with any of the alcohols. It is afterwards purified.

Properties.—A limpid, colorless, volatile, liquid, of an agreeable ethereal odor and sweetish taste; not inflammable; scarcely soluble in water; soluble in alcohol; sp. gr. 1.494; boils at 14°. It dissolves caoutchouc, gutta-percha, resins, etc. Its *anæsthetic* properties are well known.

Ethylic Alcohol, C_4H_5O,HO, old; new, C_2H_6O (common alcohol).—Has been already described as the product of the vinous fermentation.

Ethylic Ether, C_4H_5O, old; new, $C_4H_{10}O$ (common ether; sulphuric ether).—Obtained by the action of oil of vitriol on common alcohol at a certain heat. The theory of the process is not positively settled. It may be assumed that the acid removes water; the acid itself undergoes no change.

Properties.—When pure it is colorless, limpid, of a peculiar pleasant odor; boils at 98°; sp. gr. .713; very volatile, producing intense cold by its evaporation, and used in medicine for this purpose, in the form of the *spray* (Richardson); very inflammable; soluble in 10 parts of water; very soluble in alcohol; dissolves oil and fats. Much employed as an *anæsthetic.*

This ether may be regarded as the type of all the other ethers (oxides of radicals) which can be procured, in like manner, from their respective alcohols. These different oxides unite with the acids (just like the metallic oxides), to form *compound ethers*, as the *nitric*, *sulphuric*, *phosphoric*, *acetic*, etc. etc. Likewise, the radicals themselves unite with the halogens, chlorine, bromine, iodine, etc. to form other compound ethers—the *hydrochloric*, *hydriodic*, etc. ethers. The general method of obtaining these compound ethers is by the action of one of the alcohols on the corresponding acid, or on the materials for generating this acid: thus, for *muriatic ether*, use alcohol and hydrochloric acid, or alcohol, sulphuric acid, and chloride of sodium.

Aldehyde, $C_4H_3O.HO$, old; new, C_2H_4O.—Procured from alcohol or ether, by depriving them of two equivalents of hydrogen by means of oxygen. This is effected either by passing the vapor of alcohol through a red-hot tube; by putting a coil of fine platinum wire around the wick of a burning spirit lamp; or preferably, by the action of sulphuric acid on bichromate of potassium, in presence of alcohol; the chromic acid which is formed oxidizes the alcohol into aldehyde;—itself being converted into green oxide of chromium.

Properties.—A limpid, colorless liquid, having the odor of apples; sp. gr. .790; boils at 72°.

Chloral is a *chlor-aldehyde;* 3 equivalents of H being replaced by 3 of Cl; C_2HCl_3O. *Chloral hydrate* (used in medicine) is a white translucent solid, with a strong ethereal odor and pungent taste. When chloral or its hydrate is added to an alkaline solution, it is converted into *chloroform* and a *formiate* of the alkaline metal present. This fact is supposed to explain its hypnotic action, when taken through the stomach into the blood.

Acetic Acid, $C_4H_3O_3,HO$, old; new, $C_2H_4O_2$.—Made by the direct oxidation of dilute alcohol by spongy platinum; by distillation of wood (*pyroligneous acid*); and by the oxidation of alcoholic liquors by means of a ferment. Any of the fermented liquors, if exposed to the air, *sour*, or become changed into vinegar. Common vinegar is usually manufactured from wine or cider. The strongest acetic acid (*glacial*) is made by distilling anhydrous acetate of sodium with oil of vitriol. It is a volatile inflammable liquid, boiling at 248°, and solid at 40°; sp. gr. 1.063; has a pungent smell and

taste; blisters the skin. The *acetates* are all soluble salts. Those of lead, copper, potassium, and ammonium are used in medicine.

By distilling together acetate of potassium and arsenious acid, a poisonous substance is procured, called the *fuming liquor of Cadet.* This is the oxide of a radical which has been isolated, and named *Kakodyl*, C_4H_6As, old; new, $(CH_3)As_2$; symb. Kd. It forms, like the other organic radicals, a large number of compounds, all of which are poisonous.

Amylic Alcohol (*Fusel Oil*), $C_{10}H_{11}O,HO$, old; new, $C_5H_{12}O$.—Obtained by continuing the distillation of crude corn or potato whiskey, after the greater part of the alcohol has come over.

Properties.—When pure, it is a colorless oily liquid, of a characteristic odor, irritating and poisonous; sp. gr. .818; boils at 269°; sparingly soluble in water; burns with difficulty.

Valerianic Acid, $C_{10}H_9O_3,HO$, old; new, $C_5H_{10}O_2$.—Procured from amylic alcohol by oxidation, as acetic and formic acids are derived from ethylic and methylic alcohols; generally made by the action of chromic acid. It exists in the valerian-root, from which it can be obtained by distillation.

Properties.—A colorless liquid, of an acrid, burning taste; sparingly soluble in water; boils at 176°. Some of the *valerianates* are used in medicine; others are employed as artificial *essences.*

CHAPTER III.

RADICALS NOT HOMOLOGOUS WITH ETHYL.

BENZOYL, C_7H_5O (new).

Hydride (*Oil of Bitter Almonds*), $C_{14}H_5O_2,H$, old; new, C_7H_6O.—Obtained by distillation of bitter almonds with water. It does not pre-exist in the almond, but is the result of the reaction of *amygdalin* with emulsin or *synaptase*—a nitrogenized principle—and water; hydrocyanic acid is formed at the same time.

Properties.—When pure, it is colorless, inflammable, slightly soluble in water, freely so in alcohol and ether; sp. gr. 1.043; not poisonous; but, as usually found in the shops, it contains some of the poisonous hydrocyanic acid. On exposure, it absorbs oxygen, and is changed into benzoic acid.

Benzoic Acid, $C_{14}H_5O_3O,HO$, old; $C_7H_6O_2$.—The alcohol of the series. Procured largely by sublimation from the balsams—especially *benzoin;* also from the putrid urine of horses and cows, resulting here from the decomposition of the *hippuric* acid.

Properties.—A light, feathery, crystalline body, of an agreeable odor; melts below 212°; slightly soluble in water; freely so in alcohol. The *benzoates* are all soluble.

BENZOL, or *benzene*, $C_{12}H_6$, old; new, C_6H_6.—Obtained by distilling benzoic acid with hydrate of lime; or by distilling bitumin-

ous coal. It must not be confounded with *benzine*—the naphtha of petroleum.

Properties.—A thin, limpid, colorless, inflammable liquid; sp. gr. .855; boils at 176°; solid at 32°. It has been regarded as the hydride of the radical PHENYL, $C_{12}H_5$, old system; of which *phenic* or *carbolic acid* is the alcohol.

Nitrobenzene (*Essence of Mirbane*), $C_{12}H_5NO_4$, old; new, $C_6H_5(NO_2)$.—A *substitution compound* of benzol, in which hydrogen is substituted by peroxide of nitrogen. Procured by acting on benzol with fuming nitric acid. It is a heavy, yellow, sweet liquid; sp. gr. 1.209; having an odor like bitter almonds; boils at 415°; insoluble in water; used in perfumery; very poisonous. By nascent hydrogen it is converted into *aniline*, $C_{12}H_7N$, old; new, C_6H_7N.—*Aniline* is an oily, colorless liquid, of the density 1.028; boiling at 360°. It unites with acids, forming beautiful crystalline salts; the *sulphate* gives with bichromate of potassium the splendid purple or *mauve* color so much prized in dyeing; various other colors are derived from it.

Phenic or *carbolic acid* has already been described.

CINNAMYL, $C_{18}H_7O_2$, old; new, C_9H_7O.—Like benzyl, this radical, when combined with hydrogen, yields an oil—the *oil of cinnamon*, $C_{18}H_7O_2,H$, old; new, C_9H_8O. Its hydrated oxide forms an analogous acid—*cinnamic acid*.

SALICYL, $C_{14}H_5O_4$, old; new, $C_7H_6O_2$.—The radical of a new series, of which the hydride, $C_{14}H_5O_4,H$, is identical with the *oil of meadow sweet*.

Salicin, $C_{26}H_{18}O_{14}$, old; new, $C_{13}H_{18}O_7$, is the bitter crystalline principle found in willow and poplar bark.

CHAPTER IV.

ORGANIC OR VEGETABLE ACIDS.

THESE acids are widely diffused throughout the vegetable kingdom; many of them pre-exist in the plants, though generally combined with bases; others are the products of the reaction of heat.

ACETIC ACID has already been treated of.

OXALIC ACID, $C_4O_6,2HO$, old; new, $C_2H_2O_4$.—Found in combination with potassium and calcium in many plants, especially the sorrel (*oxalis*); made by the action of nitric acid on most of the amylaceous group, especially starch and sugar. The acid imparts oxygen to these bodies. It is in colorless crystals, somewhat resembling Epsom salts; very sour, soluble in water, and poisonous. Employed for removing ink-stains. It is bibasic.

CITRIC ACID, $C_{12}H_5O_{11},3HO$, old; new, $C_6H_8O_7$.—Exists in the fruits of the genus *Citrus*, including the lemon, lime, sour orange, and citron; also in several others, combined with malic acid; prepared by neutralizing lemon-juice with lime, decomposing the citrate of calcium with sulphuric acid, and evaporating; occurs in large colorless crystals, very sour, and soluble in water; it is tri-

basic. It forms salts, of which the citrates of potassium and magnesium are used in medicine; distinguished from tartaric acid, by its forming no precipitate with potassa.

MALIC ACID, $C_8H_4O_8,2HO$, old; new, $C_4H_6O_5$, derives its name from the apple (*malum*), in which it largely exists; found also in the pear, plum, and rhubarb-stalk. Prepared as citric acid; it is deliquescent; of an acid taste; bibasic.

TARTARIC ACID, $C_8H_4O_{10}2HO$, old; new, $C_4H_6O_6$.—The acid of grapes, tamarinds, and other fruits, in which it is combined with potassium. During the process of fermentation of wine, the acid tartrate of potassium is precipitated, forming a coating on the inside of the casks, called *argol*, or *tartar*. When this is washed and purified, it constitutes the *cream of tartar* of the shops, $KO,HO,C_8H_4O_{10}$, old; new, $KC_4H_5O_6$. The acid is procured from the crude tartar by neutralizing with lime, and subsequent decomposition by sulphuric acid.

Properties.—Large, colorless, transparent crystals; very sour; soluble in water; much used in calico printing; it is bibasic; its most important salts are:—

Cream of Tartar (bitartrate), already spoken of; it is the *acid tartrate of potassium*, though improperly called bitartrate. When boiled with a strong base, the latter displaces the water in its composition, and the result is a *double tartrate*.

Tartrate of Potassium and Sodium (*Rochelle Salt*), $KO,NaO\overline{T}+8HO$, old; new, $KNaC_4H_4O_6$.—Made by boiling cream of tartar with carbonate of sodium; in large colorless crystals; soluble.

Tartrate of Antimony and Potassium (*Tartar Emetic*), $KO,SbO_3\overline{T},+4HO$, old; new, $KSbC_4H_4O_7$.[1]—Made by boiling cream of tartar and oxide of antimony in water; occurs in octohedral crystals; soluble in water; of an austere, metallic taste.

Test for tartaric acid; it gives with a salt of potassium a white precipitate (cream of tartar). Heat converts it into *pyrotartaric acid*.

RACEMIC ACID, found in the juice of certain grapes, is isomeric with tartaric acid.

TANNIC ACID, $C_{54}H_{19}O_{31},3HO$, old; new, $C_{27}H_{22}O_{17}$.—The astringent principle of several plants, as the oak, chestnut, hemlock, etc. It is best obtained by the action of common ether on powdered nut-galls; the water of the ether dissolves out the acid, while the ether retains the impurities; it is in the form of a light yellowish porous mass, not crystallizable; has a pure astringent taste; soluble in water, alcohol, and glycerin; reddens litmus; forms *tannates*.

Tests.—Gives to the persalts of iron, a deep bluish-black color (the basis of common ink); also precipitates most of the metallic salts; with gelatin it forms a copious precipitate, which is the basis of *leather* (tannate of gelatin).

GALLIC ACID, $C_7HO_3,2HO$, old; new, $C_7H_6O_5$, is usually found in combination with tannic acid; believed to result from oxidation of the latter; it is less soluble than tannic acid, and does not precipitate gelatin; by heat, it is converted into *pyrogallic acid*, which is a powerful *reducing* agent.

[1] SbO acting here (exceptionally) as a univalent radical.

CHAPTER V.

ORGANIC OR VEGETABLE ALKALIES.

THE vegeto-alkalies, or *alkaloids*, constitute a peculiar class of bodies. They are found in various plants, always in combination with some acid, which itself is frequently peculiar in its nature, and not occurring elsewhere in the vegetable kingdom. They are generally very insoluble in water, but soluble in hot alcohol, and some in ether. Their taste in solution is intensely bitter; and their action on the animal economy very powerful; hence, they are valuable as medicines. They all contain nitrogen, and are of very complex composition. None of them have yet been artificially made. Only the most important will here be noticed.

MORPHIA, $C_{34}H_{19}NO_6 + 2HO$, old; new, $C_{17}H_{19}NO_3$.—Found in opium, along with *narcotina*, *codeia*, *thebaina*, *papaverina*, etc., combined with *meconic acid*, as a meconate; obtained from an infusion of opium by means of ammonia, which precipitates the morphia and other alkaloids. It is in small shining crystals, colorless; almost insoluble in water; very soluble in hot alcohol; nearly insoluble in ether; forms soluble salts with the acids, the most important of which are the *sulphate*, *muriate*, and *acetate*.

Tests.—Nitric acid gives a blood-red color with it (so it does with *brucia* and *delphia*); it gives a blue color with perchloride of iron; decomposes iodic acid, liberating iodine.

NARCOTINA, $C_{46}H_{25}NO_{14} + 2HO$, old; new, $C_{22}H_{23}NO_7$, is separated from the other principles of opium by boiling ether, which yields it by evaporation.

CODEIA, $C_{36}H_{21}NO_6 + 2HO$, old; new, $C_{18}H_{21}NO_3$, is freely soluble in alcohol or ether, and partly so in water. It produces no color with the salts of iron.

In testing for *opium* in case of poisoning, the aim is always to identify the *meconic acid*, the presence of which is conclusive. It is extracted by means of alcohol, acidulated with muriatic acid; when concentrated, the solution strikes a blood-red color with the persalts of iron, which is *not* removed by corrosive sublimate; by which it is distinguished from *sulphocyanogen*.

QUINIA, $C_{40}H_{24}N_2O_4 + 6HO$, old; new, $C_{20}H_{24}N_2O_2$.—Is one of the active principles in Peruvian bark; exists in combination with *kinic acid*. Occurs in light flocculent masses, also in crystals. Very little soluble in water; soluble in alcohol and chloroform; slightly so in ether. The tannate, oxalate, tartrate, and acetate are insoluble. Its solution in water has an opalescent appearance.

Tests.—Produces an emerald-green color in chlorine water and ammonia. With acetic acid, alcohol, and tincture of iodine, it gives beautiful green plates (Herapath).

CINCHONIA, $C_{40}H_{24}N_2O_2$, old; new, $C_{20}H_{24}N_2O$.—Exists with quinia in the Peruvian bark; crystallizes. Differs from quinia in not giving the green color to chlorine water and ammonia. Used in medicine as a substitute for quinia. The most important salt of quinia and cinchonia is the *sulphate*.

QUINIDIA and CINCHONIDIA are isomeric, respectively, with quinia and cinchonia.

Quinoidine appears to be a mixture of uncrystallizable quinia and cinchonia; it is sold under the name of *extract of bark*.

By the action of heat on quinoidine two new isomeric bodies are developed—*quinicine* and *cinchonicine*, which are chiefly remarkable for the mode in which they affect the plane of polarized light.

STRYCHNIA, $C_{42}H_{22}N_2O_4$, old; new, $C_{21}H_{22}N_2O_2$.—This, along with brucia, is the active poisonous principle of the Strychnos Nux Vomica, St. Ignatius' bean, and false Angustura bark. The alkaloids exist combined with *igasuric acid*. When pure, in white crystals; of an intensely bitter taste; scarcely soluble in water; much more so in alcohol; slightly in ether; most in chloroform. Its salts are crystalline and soluble, and excessively poisonous.

Test.—The beautiful play of colors when touched with a drop of sulphuric acid and a fragment of bichromate of potassium or red prussiate of potash; also the tetanic spasms produced by it in the frog (the *physiological* test of Dr. Marshall Hall).

BRUCIA, $C_{46}H_{26}N_2O_8 + 8HO$, old; new, $C_{23}H_{26}N_2O_4$.—Is more soluble in water than strychnia. Distinguished from strychnia by the red color produced by nitric acid.

VERATRIA, $C_{64}H_{52}N_2O_{16}$, old; new, $C_{32}H_{52}N_2O_8$.—Exists in the *Veratrum album* and *viride*.

ACONITIA, $C_{60}H_{47}NO_{14}$, old; new, $C_{30}H_{47}NO_7$.—The active principle of the aconite. It is the most poisonous of the alkaloids. The best *test* is the numbness produced by the application of the smallest particle upon the tongue.

ATROPIA, $C_{34}H_{23}NO_6$, old; new, $C_{17}H_{23}NO_3$.—From belladonna. In silky crystals; partially soluble in water.

Besides the above there are also *emetia* or *emetin* from ipecacuanha; *delphinia* from delphinum; *piperina* or *piperin* from pepper; *caffein* and *thein* from coffee and tea; *theobromin* from cocoa (cacao);[1] *conia* from conium maculatum; *nicotina* or *nicotia* from tobacco (the two latter are oily liquids).

There are also numerous *neutral bodies*, containing no nitrogen, which frequently constitute the active principles of the vegetables in which they occur. Some of these are *salicin*, *phloridzin*, *santonin*, *colocynthin*, *digitalin*, *colchicin*, *gentianin*, *quassin*, *elaterin*, etc. etc.

[1] Caffein, according to Fownes, is *methyl-theobromin*; but some chemists assert that caffein, thein, and theobromin are identical.

CHAPTER VI.

ARTIFICIAL ORGANIC BASES.

THESE are very numerous, and are mostly *substitution* compounds. The best mode of studying their constitution is by comparing them with ammonia; for, like ammonia, they all contain nitrogen, have alkaline properties, and combine with acids to form salts. They may, indeed, be considered as ammonia, in which one or more equivalents of hydrogen are replaced by the same number of equivalents of the compound radicals, *ethyl*, *methyl*, etc., thus, on the old method :—

(1.) NH_3	Ammonia.
$N(C_4H_5)H_2$ . . .	Ethyl-ammonia, or Ethylamine.
$N(C_4H_5)_2H$ . . .	Diethyl-ammonia, or Diethylamine.
$N(C_4H_5)_3$ . . .	Triethyl-ammonia, or Triethylamine.

Under the new arrangement, these will be :—

NH_3	Ammonia.
$N(C_2H_5)H_2$	Ethylamine.
$N(C_2H_5)_2H$	Diethylamine.
$N(C_2H_5)_3$	Triethylamine.

In the same way, we have the different *methyl-ammonias*, the *amyl-ammonias*, and the *phenyl-ammonias*. Under the last, we find *phenylamine*, or *aniline*, $N(C_{12}H_5)H_2$, old notation; new, $N(C_6H_5)H_2$.

Again, all three equivalents of hydrogen may be replaced by three distinct compound radicals, thus, *methyl- ethyl- amyl*-amine.

(2) *Ammonium*, NH_4, is known only in combination. In its compounds, we may, in like manner, replace the hydrogen. Thus NH_4Cl may become $NH_3(C_4H_5)Cl$, *chloride of ethylammonium* (new, $NH_3(C_2H_5)Cl$); or *chloride of diethylammonium;* or all the hydrogen may be replaced by three distinct radicals, as *chloride of methyl- ethyl- amyl*-ammonium.

(3) The hydrogen of the introduced radical may be further replaced by the halogens, chlorine, iodine, etc.; by NO_4, (NO_2, new system); by certain metals, and by alcohol radicals; thus, in the aniline series :—

Aniline (Phenyl-amine).	Nitraniline.
Chloraniline.	Zincaniline.
Bromaniline.	Ethylaniline.
Bibromaniline.	Methyl- ethyl- amylaniline.
Tribromaniline.	

(4) The nitrogen of the ammonia or ammonium may be replaced by *phosphorus*, *arsenic*, or *antimony*, thus :—

$As(C_4H_5)_3$, new, $As(C_2H_5)_3$	.	Triethylarsine.
$Sb(C_4H_5)_4I$, new, $Sb(C_2H_5)_4I_2$	.	Iodide of tetrethylstibammonium.
$P(C_4H_5)_3$, new, $P(C_2H_5)_3$	. .	Triethylphosphine.

These compounds are occasionally found in organic bodies, or result as products of their decomposition.

Of the above-named substances, the most important is *aniline.* This is prepared by heating carbolic acid (phenol) with ammonia in sealed tubes; or, by more complicated processes, from indigo or nitrobenzene. Aniline is a thin, colorless, oily liquid, with a burning taste and faint aromatic odor. It is volatile, boiling at 260° F. It becomes yellow and resinous upon long exposure to the air. Sp. gr. 1.028. It is moderately soluble in water; freely so in alcohol and ether. Although neutral to test-paper, it forms many crystallizable compounds with acids. With chromic acid, it has a characteristic reaction, producing a deep greenish or bluish-black precipitate. Solution of chloride of lime gives with aniline a violet color.

Aniline is the source of some much-admired colors for dyeing; as *aniline purple* or *mauve*, *aniline red* (magenta, fuchsine, etc.) or *rosaniline*, *aniline blue*, *yellow*, and *violet.* These dyes are somewhat less permanent than those of a mineral nature; and unwholesome effects attend the processes of their manufacture, as well as, in some instances, wearing next to the skin garments colored with them. Perhaps the most valuable practical application of the methods of modern chemistry has been the artificial production (through the investigations of Schunk, Graebe, Liebermann, and Perkins) of *alizarin*, the coloring principle of madder, from anthracene, a hydrocarbon obtained from coal tar.

CHAPTER VII.

OILS AND FATS.

OILS are divided into two classes, *fixed* and *volatile.* The former produce a greasy stain on paper, permanent when heated; the stain of the latter is dissipated by heat. Oils are also divided into *vegetable* and *animal* oils, or *fats.* There is no essential difference between these two classes; they vary chiefly in their degree of consistence. Oils have more or less attraction for oxygen; some of them to such an extent as to produce combustion when in contact with light inflammable substances, as cotton. This is apt to occur with linseed oil. From this results the division of oils into *drying*—such as linseed, poppy-seed, etc., oils, and *non-drying;* the former are used in painting.

The parts of plants which contain most oil are the seeds. Olive oil is procured from the fruit itself.

Properties.—Generally they are lighter than water; their melting point varies; some are solid at ordinary temperatures (the fats);

others are fluid. In general, the greater the proportion of their carbon, the lower their melting point.

Fixed Oils.—Obtained from vegetables by crushing the seeds or other portions, and subjecting to strong pressure, with heat. From animals, by melting, so as to allow their escape from the fat cells.

Properties.—Usually colorless, or of a slight yellow tinge; of very little odor and taste; frequently, however, a peculiar odor is imparted by the presence of a volatile fatty acid, as *butyric*, *capric*, etc. Insoluble in water; nearly so in alcohol (except castor oil, which is freely soluble) very soluble in ether, benzol, and the volatile oils. Heated to near 500° they change color, and evolve offensive odors; above 500° they decompose into several odorous bodies, among which is *acrolein*, $C_6H_4O_2$ (new, C_3H_4O), an acrid body; at a still higher temperature, they give off light and heavy carburetted hydrogen.

They all consist of carbon, hydrogen, and oxygen. Although apparently homogeneous in their composition, they in reality contain several proximate principles—*stearin*, *margarin* (palmitin), and *olein* or *elain*. The two former are solid, the latter is liquid, at ordinary temperatures. Stearin is the solid principle of animal fats; margarin or palmitin of vegetable oils: olein is the fluid principle in both. These principles can be isolated by the action of boiling alcohol, which, on cooling, deposits the stearin and margarin, but retains the olein. The palmitin may be separated from the stearin by ether; and the olein from the alcohol by distillation. These three principles consist, respectively, of a peculiar fat acid —*stearic*, *palmitic*, and *oleic*—united to a common base, *glycerin*.

Saponification.—When a fixed oil is boiled with an alkali in water, a *soap* is formed, produced by the chemical union of the fatty acid with the alkali, and setting free the glycerin. Common *soft soap*, made by the action of the lye of wood ashes on fat, is a *stearate of potassium*. *Hard soap* is made from soda. If a soap be decomposed by an acid, the particular fatty acid contained in the soap will be precipitated, while the alkali unites with the decomposing acid used. The formation of *lead plaster* is a true instance of saponification, an oleo-margarate of lead being formed, while the glycerin is retained in the water.

Fatty Acids.—These may be obtained as above mentioned by decomposing soaps by a mineral acid. They are generally homologous with acetic acid. Most of them are liquid, volatile, and generally of a highly offensive odor. The highest members of the series are solid, white, fusible, volatile, tasteless, and inodorous.

Glycerin, $C_6H_8O_6$, old; new, $C_3H_8O_3$; *propenyl alcohol.*—Obtained from fats, by the action of steam at the temperature of 500°; also in the process of saponification. It is a colorless, inodorous, syrupy liquid, of a sweetish taste, and fermentable; sp. gr. 1.273; soluble freely in water and alcohol; insoluble in ether; does not become dry or rancid when exposed to the air. It is a powerful solvent. It cannot be distilled alone without decomposition; combines with acids. *Nitro-glycerin* is formed by a cooled mixture

of nitric and sulphuric acids on glycerin. It is a very explosive substance; colorless; oily; sp. gr. 1.6; very poisonous.

Glycerin does not pre-exist in fats, but is formed during saponification. It may be regarded as the *oxide of allyl.*

Spermaceti.—Found in the cranium of a certain species of whale, in union with an oil. It has a crystalline structure; melts at 120°; somewhat soluble in boiling alcohol; also in ether. It is saponified with difficulty—two substances resulting, called *ethal* and *ethalic acid.*

Wax.—This substance, whether procured from the bee or from the pollen and leaves of flowers, consists of two distinct principles —*cerin* and *myricin.* They may be separated by boiling alcohol.

VOLATILE OILS.—These are very numerous in the vegetable kingdom, imparting their peculiar flavor to plants. Obtained usually by distillation with water; sometimes by expression.

Properties.—When pure they are colorless, but generally have a slight tinge; powerful odor and taste; do not saponify; absorb oxygen when exposed to the air; slightly soluble in water; miscible with fixed oils in all proportions; very soluble in alcohol and ether. They are conveniently divided into (1) those composed of carbon and hydrogen; (2) those containing carbon, hydrogen, and oxygen; (3) those containing sulphur.

The first class are all isomeric with Oil of Turpentine, $C_{10}H_{16}$. They are inodorous when absolutely pure, but as commonly seen have more or less odor. They become *resinoid* by absorption of oxygen. The following are examples of this class: Oils of turpentine, copaiba, camphor, black pepper, hemlock, juniper, savin, lemon, and orange.

The second class (containing oxygen) constitute the great bulk of the volatile oils. They consist of two proximate principles, one a solid (*stearoptin*); the other liquid (*eleaoptin*).

The third class (containing sulphur) are very pungent, and of a powerful odor. The oils of garlic, horseradish, assafœtida, and mustard are examples.

CAMPHORS and RESINS are the products of oxidation of the volatile oils.

Camphor, $C_{10}H_8O$, old; new, $C_{10}H_{16}O$, may be regarded as the type of the group. It is a solid, colorless, volatile, inflammable body, nearly insoluble in water; soluble in alcohol.

The *Resins* are usually found in plants associated with some volatile oil. Common rosin (*colophony*) is a good illustration. It is procured by the distillation of crude turpentine; the volatile oil of turpentine passes over, leaving the resin behind. They are insoluble in water; soluble in alcohol; in volatile and fixed oils; inflammable; yield in distillation carburetted hydrogen and other products. They may be saponified. The most common resins are *rosin*, *lac*, *copal*, *mastic*, *dammar*, and *dragon's blood.*

Amber is a fossil resin.

Balsams are compounds of resin, volatile oil, and benzoic acid. The *balsams of Peru* and *Tolu* are examples.

Caoutchouc, or *India rubber*, and *gutta percha* are the dried juices of certain tropical plants. They are insoluble in water and alcohol; sparingly soluble in ether and volatile oils; very soluble in

chloroform. By heating with sulphur, the elasticity of caoutchouc is increased, and its structure otherwise changed; it is then said to be *vulcanized.*

CHAPTER VIII.

ANIMAL COMPOUNDS.

THE *albuminous* or *protein* bodies comprise Albumen, Fibrin, and Casein, with others of less importance. The chemical formulæ of these three bodies have not been positively settled; but their analysis gives, in 100 parts, the following results:—

	Albumen.	Fibrin.	Casein.
Carbon	53.5	52.7	53.83
Hydrogen	7.0	6.9	7.15
Nitrogen	15.5	15.4	15.65
Oxygen	22 0	23.5	
Sulphur	1.6	1.2	23.37
Phosphorus	0.4	0.3	

ALBUMEN.—Found nearly pure in the white of eggs (whence its name); in the serum of the blood; and in vegetables.

Properties.—Exists in two states: as a *liquid*, in the white of eggs, in serum, in the humors of the eye, in lymph and chyle; and as a *solid* (probably somewhat modified) in brain and nerves, in skin, glands, membranes, etc., and in the seeds of plants. In the former condition it is colorless and tasteless, soluble in alkaline solutions; in the latter, it is translucent, horny, and amorphous. Albumen is coagulated by heat, nitric acid, corrosive sublimate, and other metallic salts, tannin, creasote, alcohol, and by electricity. Owing to the action of corrosive sublimate, it is used as an antidote for that poison; making with it an inert compound.

Vegetable albumen (*emulsin*) may be procured best from almond-cake, after the oil has been pressed out. It has nearly all the properties of animal albumen.

FIBRIN.—Exists in a fluid and solid state; the former, in blood, chyle, and lymph; the latter (*myosin*), in muscles and coagulated blood. Can be procured from muscles; or preferably by whipping freshly drawn blood with a twig; the fibrin adheres to it in long white filaments. The characteristic of fibrin is its spontaneous coagulability. This is the reason why blood coagulates when drawn from a vessel. The average in the blood in health is 2 to 3 parts in 1000. Albumen is converted into fibrin in the body, by a process of oxidation.

Vegetable fibrin (*gluten*) is the opaque, white, tenacious matter, obtained by washing wheaten flour in a stream of water; the starch is carried away, leaving the gluten behind; it is the *nitrogenized*, and therefore the true nutritious ingredient in flour.

CASEIN.—Exists in milk, and is the basis of cheese; it owes its fluidity in milk to the presence of an alkali; if this be removed by an acid (spontaneously, by lactic acid, in the souring of milk), the casein is precipitated.

Vegetable casein (*legumin*) exists chiefly in peas, beans, etc.; it closely resembles the casein of milk.

There are a number of *albuminoid* bodies which can only be mentioned here: *globulin*, *pyin*, *mucosin*, *ptyalin*, *pancreatin*, *neurin*, *crystallin*, etc.

From either albumen, fibrin, or casein, *protein* may be obtained by dissolving them in an alkaline solution, and then precipitating with an acid.

The *gelatinous group* comprises gelatin, ostein, and chondrin; they constitute the basis of bones, cartilages, tendons, skin, membranes, etc.

GELATIN.—Procured by long boiling of bones, skin, or tendons (not from cartilage). When pure and dry, it is a transparent, colorless, inodorous solid; soluble in boiling water; insoluble in alcohol and ether; its aqueous solution *gelatinizes* on cooling. Familiar varieties of gelatin are *glue*, *size*, *isinglass*, and *calf's foot jelly*. It is soluble in all dilute acids except tannic. It is not precipitated by alum, acetate, or subacetate of lead. It is characterized by being precipitated by *tannic acid*, even when in minute quantities. OSTEIN is bone-gelatin.

CHONDRIN.—The variety found in cartilage differs from gelatin in being precipitated by acetic acid, nitric acid, and subacetate of lead.

CREATIN, $C_8H_9N_3O_4 + 2HO$, old; new, $C_4H_9N_3O_2.2H_2O$.—Extracted from the juice of flesh. It is a neutral body; in brilliant colorless crystals; soluble in boiling water; of a bitter acrid taste.

CREATININ, $C_8H_4N_3O_2$, old; new, $C_4H_7N_3O$, is formed from creatin by the action of acids, which remove the elements of water. It occurs in crystals; has an alkaline reaction, and combines with acids to form salts.

INOSINIC ACID is also found in the juice of flesh.

The different solids and fluids of the body—*nerve-substance*, *blood*, *bile*, *milk*, *urine*, etc.—contain various interesting principles; but the space here allowed will admit only of a very cursory examination of the most important of them. For a more detailed account, the student is referred to the division of PHYSIOLOGY.

Bones consist of variable proportions of animal and earthy matters; the former (*ostein*) being in the proportion of about one-third; the latter (chiefly *phosphate* and *carbonate of calcium*), about two-thirds. *Teeth* have a similar structure, but contain more earthy matter.

Nerve-substance.—The brain and nerves are composed of about 7 to 9 per cent. of albumen; 5 to 14 of peculiar fatty principles, and 75 to 80 of water. Among the fatty principles, the most important are, *cerebric* and *oleo-phosphoric acids*, with *cholesterin* and *lecithin*. Both the acids contain *phosphorus*. *Protagon* has been obtained by Liebreich from brain-substance.

Blood is composed, proximately, of water, albumen, fibrin, corpuscles, salts, extractive and fatty matter. The *water* amounts to about 784 parts in 1000; the corpuscles (consisting of *globulin* and *hæmoglobin*, or red coloring matter), 131 parts; *albumen*, 70; *salts* (of sodium, potassium, calcium, magnesium, and iron), 6; *fibrin*, 2.2; *extractives*, etc., 6.77.

Bile.—In man, has a sp. gr. of 1.018; is neutral; of a bitter taste. Contains in 1000 parts, 880 of *water;* 90 of *glycocholate* and *taurocholate of sodium;* 15.24 of other salts (*chloride of sodium, carbonates of sodium* and *potassium, phosphates of sodium, potassium, calcium,* and *magnesium*); 13.42 of *biliverdin, cholesterin,* and *fats;* and 1.34 of *mucus.*

Tests.—Nitric acid produces a grass-green color with the biliverdin. A solution of sugar and sulphuric acid, added to a solution of bile, and gently warmed, produces a deep reddish-purple color (Pettenkofer).

Urine.—In its normal state, is a clear liquid, of an amber color; sp. gr. 1017 to 1030, depending on the nature of the food and drink; has an acid reaction when first secreted; becomes alkaline on standing, and deposits its mucus and salts.

Urine contains, in 1000 parts, about 967 of *water;* 14 of *urea;* 1 of *creatin* and *creatinin;* 2 of *urates* of *potassium, sodium,* and *ammonium;* 8 of salts (*phosphates* of *sodium, potassium, calcium,* and *magnesium, chlorides* of *sodium* and *potassium, sulphates* of *sodium* and *potassium*); 10 of *mucus* and *coloring matter.*

Urea, $C_2H_4N_2O_2$, old; new, CN_2H_4O, constitutes nearly one-half of the solid portions of the urine; about 400 grains are discharged daily from a healthy adult, the amount varying chiefly with the diet and exercise. It is obtained as a nitrate by concentrating the urine to one-third, and adding nitric acid. It is the principal outlet for the effete nitrogen of the system.

Properties.—In colorless neutral prisms, soluble in water and alcohol; forms salts with acids; is easily decomposed, in contact with a ferment, into carbonate of ammonia and water. It is identical with the *cyanate* of *ammonia,* NH_4O,C_2NO, and can be artificially formed.

Uric Acid, $C_{10}H_2N_4O_4 + 2HO$, old; new, $C_5N_4H_4O_3$.—Exists in healthy urine in very small quantities; is procured from the excrement of serpents and birds. It is a soft, white, crystalline powder; soluble in 10,000 parts of water; insoluble in alcohol and ether.

Tests.—A few drops of pure nitric acid cause decomposition; if this be now gently heated to dryness, a deep red stain is left, which, when cool, is to be touched with a drop or two of solution of ammonia, when a rich purple (*murexide*) is produced.

Hippuric Acid, $C_{18}H_8NO_5,HO$, old; new, $C_9H_9NO_3$, replaces uric acid in the urine of the herbivora. When such urine is allowed to putrefy, this acid is converted into *benzoic* acid.

The different *phosphates* of the urine are held in solution by the acid phosphate of sodium. When the urine becomes alkaline, they are deposited.

Mode of Testing Morbid Urine.

A few simple experiments will generally enable us to determine this question. The urine should first be tested with blue and reddened litmus paper, for acidity or alkalinity; next, its sp. gr. should be determined by means of the urinometer; the deposits, if any, should be allowed to subside, after which the clear liquid should be poured off, and the portion containing the sediment should be examined first.

In the majority of cases the urinary deposits will be found to consist of one or other of the following: *urate of ammonium* or *sodium*, *earthy phosphates*, *uric acid*, and *oxalate of lime* (oxalate of calcium).

First, warm a little of the turbid urine in a test-tube, over a spirit lamp; if it readily clears up by the dissolving of the sediment, the deposit most probably is one of the *urates*.

Secondly, if the deposit does not dissolve by heat, add to some of the turbid urine a few drops of acetic acid; if this readily dissolves it, it most probably consists of one or more of the *earthy phosphates*.

Thirdly, if the deposit is soluble neither by heat nor in acetic acid, try some of it with dilute hydrochloric acid; if soluble in this, and the acid solution yields when neutralized by ammonia a white precipitate, it is probably *oxalate of calcium*.

Fourthly, if the deposit proves insoluble by the three foregoing agents, it may be tested for *uric acid*. Should the deposit prove to be none of the above-mentioned substances, it may be examined for *mucus*, *pus*, *blood*, *cystine*, *chylous*, and *fatty matter*.

In examining the clear urine from which a deposit has subsided, or which contains no deposit, the first points to be determined are acidity or alkalinity, and the specific gravity. If the sp. gr. is higher than 1025, the urine may contain *sugar*, or *an excess of urea*. The presence of *sugar* is determined by *Trommer's* test, which consists in adding to a small quantity of the suspected urine, in a test-tube, a few drops of a solution of sulphate of copper, and then solution of potassa in excess; the tube is then to be held over the flame of a spirit lamp until it boils; a reddish precipitate determines the presence of sugar. An *excess of urea* is shown by adding to a few drops of the urine, in a watch-glass, an equal quantity of pure nitric acid, and cooling; if crystals of nitrate of urea form, the urea was in excess.

The presence of *albumen* is determined by boiling a little of the urine in a test-tube; coagulation, more or less dense, takes place; a few drops of nitric acid are now added, which will increase the density of the deposit if it be albumen. If the urine should be strongly alkaline, the albumen is not precipitated by boiling *alone;* nitric acid should be added.

The *earthy phosphates* in excess are detected by boiling the urine, as in the case of albumen; but on addition of the acid, *the precipitate entirely disappears*.

If the urine is very high colored, it probably contains an excess of *coloring matter*; or *bile*, *blood*, or *purpurin* is present, which may be identified by the appropriate tests.

In the examination of morbid urine, the *microscope* affords invaluable aid; a drop or two of the urine being placed upon the glass slide yielding often abundant evidence of the excess of any of the solid constituents.

Urinary calculi are composed chiefly of one or more of the following substances: *uric acid*, *urate of ammonium*, *phosphate of lime* (phosphate of calcium), *ammonio-magnesian phosphate*, and *oxalate of calcium*, besides some rarer forms.

TABLE EXEMPLIFYING QUALITATIVE ANALYSIS (Attfield),

For an Aqueous Inorganic Saline Solution.

Add hydrochloric acid, and filter.

<table>
<tr><td colspan="3">Precipitate
Hg(ous) Pb Ag.
Wash, boil with H_2O, filter.</td><td colspan="10">Filtrate
Cu Hg(ic) Pb As Sb Fe Al Zn Ba Ca Mg K Na Am.
Pass H_2S through the liquid; filter.</td></tr>
<tr><td colspan="2">Precipitate
Hg Ag.
Add AmHO.</td><td rowspan="4">Filtrate
Pb.
Add H_2SO_4; white precipitate.</td><td colspan="3">Precipitate
Cu Hg Pb As Sb.
Wash, digest in AmHS; filter.</td><td colspan="7">Filtrate
Fe Al Zn Ba Ca Mg K Na Am.
Add AmHO, AmHS, and filter.</td></tr>
<tr><td rowspan="3">Precipitate
Hg.
Black precipitate.</td><td rowspan="3">Filtrate
Ag.
Add HNO_3; white precipitate.</td><td rowspan="3">Precipitate
Cu Hg Pb.
Wash, dissolve in a few drops of HNO_3 and HCl; evap. nearly to dryness; redissolve in H_2O, divide into three, and test for
Cu by AmHO; blue solution.
Hg by Cu; globules.
Pb by H_2SO_4; white precip.</td><td colspan="2">Filtrate
As Sb.
Add $HC_2H_3O_2$, and boil; digest the precipitate in strong HCl; boil, dilute; filter.</td><td colspan="3">Precipitate
Fe Al Zn.
Wash, dissolve in HCl, boil (with a few drops of HNO_3 if necessary), add KHO, stir, filter.</td><td colspan="4">Filtrate
Ba Ca Mg K Na Am.
Add Am_2CO_3; boil, filter.</td></tr>
<tr><td>Precip.
As.
Yellow.</td><td>Filtrate
Sb.
Add H_2S; Orange precip.</td><td rowspan="2">Precipitate
Fe, ferrous or ferric. Test original solution by yellow and red prussiate.</td><td colspan="2">Filtrate
Al Zn.
Neutralize by HCl; add AmHO, stir, filter.</td><td colspan="2">Precipitate
Ba Ca
Wash, dissolve in $HC_2H_3O_2$; add K_2CrO_4; filter.</td><td colspan="2">Filtrate
Mg K Na Am.
Add Am_2HAsO_4; stir, filter.</td></tr>
<tr><td colspan="2">Confirm by testing original solution by the H tests.</td><td>Precipitate
Al.
White precipitate.</td><td>Filtrate
Zn.
Add AmHS; white precip.</td><td>Precip.
Ba.
Yellow</td><td>Filtrate.
Ca.
Add $Am_2C_2O_4$; white precipitate.</td><td>Precip.
Mg.
White.</td><td>Filtrate
K Na Am.
Evap. ignite, dis. in H_2O; test for K by $PtCl_4$, yel. precip. Na by flame; Am. in orig. solution by NaHO.</td></tr>
</table>

The group-tests of this Table are HCl, H_2S, NH_4HS, and $(NH_4)_2CO_3$.

THE METRIC SYSTEM.

MEASURES OF CAPACITY.

	In Cubic Inches.	In Cubic Feet = 1728 Cubic Inches.	In Pints = 34.65923 Cubic Inches.	In Gallons = 8 Pints = 277.27384 Cubic Inches.	In Bushels = 8 Gallons = 2218.19075 Cubic Inches.
Millilitre, or cubic centimètre . .	0.061027	0.0000353	0.001761	0.00022010	0.000027512
Centilitre, or 10 cubic centimètres	0.610271	0.0003532	0.017608	0.00220097	0.000275121
Decilitre, or 100 cubic centimètres	6.102705	0.0035317	0.176077	0.02200967	0.002751208
Litre, or cubic décimètre . . .	61.027052	0.0353166	1.760773	0.22009668	0.027512085
Decalitre, or centistère	610.270515	0.3531658	17.607734	2.20096677	0.275120846
Hectolitre, or decistère	6102.705152	3.5316581	176.077341	22.00966767	2.751208459
Kilolitre, or stère, or cubic mètre	61027.051519	35.3165807	1760.773414	220.09667675	27.512084594
Myriolitre, or decastère	610270.515194	353.1658074	17607.734140	2200.96676750	275.120845937

1 Cubic Inch = 16.3861759 Cubic Centimètres. 1 Cubic Foot = 28.3153119 Cubic Décimètres. 1 Gallon = 4.543457969 Litres.

MEASURES OF WEIGHT.

	In English Grains.	In Troy Ounces = 480 Grains.	In Avoirdupois Lbs. = 7000 Grains.	In Cwts. = 112 Lbs. = 784,000 Grains.	Tons = 20 Cwts. = 15,680,000 Grains.
Milligramme	0.015432	0.000032	0.0000022	0.00000002	0.000000001
Centigramme	0.154323	0.000322	0.0000220	0.00000020	0.000000010
Decigramme	1.543235	0.003215	0.0002205	0.00000197	0.000000098
Gramme	15.432349	0.032151	0.0022046	0.00001968	0.000000984
Decagramme	154.323488	0.321507	0.0220462	0.00019684	0.000009842
Hectogramme	1543.234880	3.215073	0.2204621	0.00196841	0.000098421
Kilogramme	15432.348800	2.150727	2.2046213	0.01968412	0.000984206
Myriogramme	154323.488000	321.507267	22.0462126	0.19684118	0.009842059

1 Grain = 0.064798950 Gramme. 1 Troy Oz. = 31.103496 Gram. 1 lb. Avd. = 0.45359265 Kilogr. 1 Cwt. = 50 80237689 Kilogr.

MEASURES OF LENGTH.

	In English Inches.	In English Feet = 12 Inches.	In English Yards = 3 Feet.	In Eng. Fathoms = 6 Feet.	In English Miles = 1760 yards.
Millimètre	0.03937	0.0032809	0.0010936	0.0005468	0.0000006
Centimètre	0.39371	0.0328090	0.0109363	0.0054682	0.0000062
Décimètre	3.93708	0.3280899	0.1093633	0.0546816	0.0000621
Mètre	39.37079	3.2808992	1.0936331	0.5468165	0.0006214
Décamètre	393.70790	32.8089920	10.9363310	5.4681655	0.0062138
Hectomètre	3937.07900	328.0899200	109.3633100	54.6816550	0.0621382
Kilomètre	39370.79000	3280.8992000	1093.6331000	546.8165500	0.6213824
Myriomètre	393707.90000	32808.9920000	10936.3310000	5468.1655000	6.2138244

1 Inch = 2.539954 Centimètres.
1 Foot = 3.0479449 Décimètres.
1 Yard = 0.91438348 Mètre.
1 Mile = 1.6093149 Kilomètre.

MEASURES OF SURFACE.

	In English Square Feet.	In Eng. Sq. Yards = 9 Sq. Feet.	In English Poles = 272.25 Sq. Feet.	In English Roods = 10,890 Sq. Feet.	In English Acres = 43.560 Sq. Feet.
Centiare, or square mètre	10.7642993	1.1960333	0.0395383	0.000988457	0.0002471143
Are, or 100 square mètres	1076.4299342	119.6033260	3.9538290	0.098845724	0.0247114310
Hectare, or 10,000 square mètres	107642.9934183	11960.3326020	395.3828959	9.884572398	2.4711430996

1 Square Inch = 6.4513669 Square Centimètres.
1 Square Foot = 9.2899683 Square Décimètres.
1 Square Yard = 0.83609715 Square Mètre or Centiare.
1 Acre = 0.404671021 Hectare.

A MANUAL

OF

MATERIA MEDICA.

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MATERIA MEDICA.

CHAPTER I.

DEFINITIONS.

THERE are in the animal, vegetable, and mineral kingdoms, a vast number of substances which, when taken internally, are capable of influencing the human system. Such substances are divisible into *aliments*, *medicines*, and *poisons*.

ALIMENTS furnish material for growth and development.

MEDICINES so influence the various functions, or modify the constituents of the body, as, when properly administered, to aid nature in returning from disease to health.

POISONS subvert the normal functions or destroy the structure of the body so as to produce disease or death. It is evident that the boundaries of these divisions are not exact. Thus an aliment is capable, in certain states of the system or in over-quantities, of acting as a poison—as sugar in diabetes—fruits in diarrhœa. Iron and cod-liver oil are at once nutriments and medicines; opium, belladonna, strychnia, and most of the more powerful medicines, in over-doses are virulent poisons.

PHARMACOLOGY or MATERIA MEDICA is the science which treats of medicines.

TOXICOLOGY, that which treats of poisons, including medicines in poisonous doses. The chief subdivisions of Materia Medica are, Pharmacy, which has for its province the preparation or compounding of medicines, and Therapeutics, which considers their application to disease.

CHAPTER II.

ACTION OF MEDICINES.

IT is evident that an aliment to act must be first absorbed and then assimilated so as to form an integral portion of the living structure. A medicine may or may not be absorbed, though when not absorbed it is perhaps more strictly a *remedy* than a *medicine;* use these terms as we may, a medicine never, as such, forms a necessary portion of the living being; just in proportion

as it is assimilated into it does it become an aliment. When a medicine then is swallowed, or enters the living being in any way, unless it have a merely local action, it is absorbed, taken up by the veins and circulated through the system with the blood, reaching the most hidden and remote parts. Most medicines have what is termed an *affinity* for some one or more organs, that is, they especially act on, and influence the life-action of such parts. Thus Epsom salts, though passing through the whole structure, acts on the bowels; whilst opium throws the weight of its power on the nervous system; broom, copaiba, etc., act on the kidneys, and so on.

It is evident that though the direct action of a medicine is thus upon the organ or organs for which it has an affinity, yet as every organ of the body is more or less under the influence of every other organ, the whole system must feel the effects of such action. Thus a powerful dose of salts acts first on the bowels, purging violently, and as the result of this the whole system may be more or less weakened. Again, in a case of dropsy, broom is administered, and the kidneys excited; the water thus drawn away from the blood causes it to take up the effusion in the cellular tissues, and the dropsy is removed. The diuresis is the PRIMARY effect of the broom, the consequent absorption and removal of the water the SECONDARY effects. The SECONDARY or THERAPEUTICAL effects of a medicine are then the consequences of the PRIMARY. It is evident that in the majority of instances a medicine is administered for its indirect or secondary effects. When castor oil is given to remove some offending substance from the bowel, we desire its *primary* effect, but when a purgative is used to deplete, to influence a dropsy, etc., we desire its secondary effects. The primary effects of a medicine may be seen in the part to which it is applied or in some distant organ. Thus, nitrate of silver applied to an ulcer alters the action of that portion which it touches, but turpentine introduced into the stomach affects the kidneys.

Medicines which act on the part to which they are applied are said to act *locally;* the others *remotely*. As was before stated, remote action is generally preceded by absorption. The proofs of such absorption are the finding of the drug in the blood and its being thrown off, changed or unchanged, in the secretions. The smell of the drunkard's breath is familiar to all—potassa soon renders the urine alkaline; a purgative given to the nurse affects the infant, who takes her milk. Medicines, or more strictly poisons, have even been found in the solid tissues of the body; as lead in the wasted muscles of the paralytic. The only other way medical impressions can be conveyed is through the nervous system; that this is not the usual method, is proven not only by the facts cited, but also by the circumstance that if the circulation in the limb of an animal be interrupted, and a poison be injected into the limb, no effect is produced, although nervous communication be intact; but fatal symptoms rapidly come on, when the interruption to the return of the blood is removed.

Absorption is dependent upon *endosmosis*, and takes place principally through the *veins*. Not only is this true of medicines, but also of food and poison, the *lacteal* or lymphatic system mostly playing a secondary part. Thus Magendie tied the lacteals, and

administered nux vomica, which very soon caused symptoms of poisoning, but when the veins were tied, the lacteals being free, no effect was produced. (Endosmosis is explained under the head of PHYSIOLOGY.) It is evident that the rapidity of the absorption, and consequently of the action of a medicine, depends on a variety of circumstances; as the chief of which may be enumerated: the part to which it is applied, the state of the circulatory system, the solubility of the medicine, and the power which it has of passing rapidly through a living membrane. If the part to which it is applied be covered with a thick, dense epidermis, or poorly supplied with bloodvessels, or if the circulatory system be excited, and the distended veins incapable of holding more than is already in them, it is evident absorption will take place very slowly. On the other hand, the absence of epidermis and an abundance of relaxed bloodvessels greatly favor absorption.

To be absorbed, medicines must be in solution, or in the form of vapor. Otherwise, it is plain, endosmosis cannot occur; but many substances insoluble in ordinary menstrua, are either changed in the stomach and bowels, or else meet there some fluid capable of dissolving them; thus metallic iron is changed into a soluble salt in the stomach. Though absorption is thus necessary to a remote effect, yet it must be borne in mind that many local remedies produce *secondary* effects. Thus, a blister may cause sufficient irritation to throw the whole system into a fever; a corrosive poison which destroys the stomach will produce profound collapse.

All remedies act in one of three ways: either mechanically, chemically, or vitally (dynamically). Examples of mechanical remedies are, a splint; cowhage, which destroys parasites by piercing them; a bandage, checking the circulation of a poison, etc. Examples of chemical action are sulphuric acid, or potassa, destroying a tissue by extracting its water and decomposing it; soda rendering the urine alkaline, etc. A medicine which acts vitally, influences in some occult way the life-force, the cell activity of a part, sometimes increasing, sometimes lowering, sometimes merely altering it. As examples may be mentioned, opium and alcohol stimulating nervous activity, tobacco and veratrum viride depressing it; turpentine exciting the cells of the kidneys and lungs, etc.

EXHIBITION OF MEDICINES.

Medicines are commonly introduced into the system through the mucous membranes, the skin, or, sometimes, the cellular tissue. The most common channel is the stomach. Its powerfully solvent secretions and great vascularity fit it for dealing with both insoluble and soluble substances. After the stomach, the rectum is most commonly employed. Absorption takes place with considerable rapidity in it; but it has no power of working up insoluble substances. It is employed more especially when the stomach rejects everything, or the patient is unable to swallow; at times it is used when it is desired to affect a neighboring viscus; as enemata of laudanum in strangury. Turpentine injections are occasionally employed to arouse the nervous system by their local action on the rectum.

Medicines may be applied to the skin, in order to affect the system, either enepidermically, or endermically; that is, to the sound skin, or to the skin deprived of its epidermis. The endermic method is chiefly used for the introduction of a morphia salt. Thus, in sickness of the stomach, a small blister is frequently applied to the epigastrium, the cuticle is cut, and half a grain of the sulphate of morphia diluted with a little powdered starch is dusted on the denuded surface.

Medicines are introduced into the system by the sound skin, *i. e.*, enepidermically, by means of inunction and baths, either of vapor or water. The simplest form of administering the vapor-bath is to elevate the patient's knees, he being closely covered up in bed, and place at his feet hot bricks wrapped in wet flannels; or the vapor may be introduced under the bedclothes, by heating the simple or medicated water and conducting the steam by means of a large funnel, the nozzle of which is inserted beneath the covers. When the vapor of a solid substance, as cinnabar or sulphur, is to be used, the patient should be placed on a stool, and a large piece of sail or India-rubber cloth should be so cut as to fit very closely around the neck and shoulders of the patient, and to fall on the floor at some distance from his person. A piece of heated iron may then be placed in the centre, beneath the stool, and the drug may be laid on it; or the solid may be vaporized by heating it on a tin plate above a spirit lamp. Care must be taken to prevent the inhalation of the acrid fumes.

Inunction, or anointing, is sometimes used when the same medicine is also being introduced through the mouth, in order very rapidly to impress the system; thus, formerly, it was much in vogue when salivation was desired. At present, inunction is rarely employed in order to affect the system. In practising it, an ointment should be made of such a nature as to readily melt at the temperature of the body, and this should be rubbed upon the inside of the thighs, or other portions of the person where the cuticle is thin. Medicines are, however, much more frequently applied to the skin for their local than remote action; thus, sulphur-ointment is used to destroy the itch insect; and the whole array of liniments, lotions, poultices, etc., are employed for their local effects. Medicines are applied for their local action, not only to the skin, but to the various mucous membranes; as instances may be mentioned the various eyewashes; injections in gonorrhœa; gargles; nitrate of silver in gastric irritation; and the inhalation of medicated vapors in chronic bronchitis.

Narcotics and other medicines are very frequently administered *hypodermically*, *i. e.*, by injecting a concentrated solution into the cellular tissue beneath the skin; which is done with a small syringe, having a sharp, needle-like steel nozzle, easily forced through the skin. This process is also practised with other remedies. The action of medicines thus introduced is very rapid and decisive.

DOSES.

The dose of a medicine is evidently not a fixed quantity, but varies within certain limits, being influenced by the amount of effect desired to be produced, the *condition*, *age*, *sex*, *temperament*,

idiosyncrasies, and *habits* of the patient, as well as the *method of administration.*

CONDITION.—The influence of disease is seen in the large amount of alcoholic stimulants borne, when the nervous system is depressed by a fever poison, or by the venom of the rattlesnake.

AGE.—The young are much more susceptible to the influence of medicines than the middle-aged, as are also the aged. The increased susceptibility of children is more marked in regard to some drugs than others. The rule of Dr. Young is, however, pretty general in its application; but narcotics and acrid substances must be given in less doses, whilst calomel and castor oil may be more freely administered. The rule is, to add 12 to the age and divide by the age; the adult dose to be divided by the resultant. Thus, in a child 6 years old, $6 + 12 = 18$, divided by $6 = 3$. The dose for such a child is thus one-third the dose for the adult.

SEX.—Females are more susceptible than men, requiring smaller doses. During pregnancy, strongly perturbating medicines, as emetics and drastic cathartics, must be used with great caution, and during menstruation, everything calculated to arrest or disturb the flow must be avoided.

TEMPERAMENTS (constitutional peculiarities characterizing *classes* of persons), as well as IDIOSYNCRASIES (peculiarities of *individuals*), evidently greatly modify the action of drugs, and must be ascertained and remembered in prescribing. Thus the lymphatic, flaccid individual is not so easily influenced by stimulants as one of a sanguine or choleric temperament.

HABIT.—The system becomes accustomed to and tolerant of most medicines when frequently repeated. This especially applies to the narcotics: witness, the tobacco or opium devotee, as compared with those who are unaccustomed to the use of either drug.

ADMINISTRATION.—The dose varies somewhat with the organ through which it is given. Thus, by the rectum one-third more may be given than by the stomach. Endermically, at least one-half more may be exhibited. In the use of the enepidermic method, the dose is seldom measured. A somewhat smaller quantity should be administered hypodermically than by the stomach.

CHAPTER III.

MEDICINES.

THE UNITED STATES PHARMACOPŒIA, or the recognized materia medica standard of the American physician, is divided into the *materia medica list* and the *preparations.*

MATERIA MEDICA LIST is an enumeration of drugs.

PREPARATIONS are various forms of those drugs, made by the apothecary, ready for immediate exhibition.

The following are the officinal preparations.

SOLIDS.

PILULÆ (*Pills*).—Small globular masses, intended to be swallowed without chewing. Large doses and deliquescent salts[1] should not be exhibited in this form. Efflorescent salts[2] may be rendered fit to be made into pills by first driving off their water of crystallization by heat.

Some substances (as extracts) may be made into pills by the use of a little water; others require the intervention of some viscid material, as gum, mucilage, syrup, honey, etc. Crumb of bread may be used, when the salt in it is not incompatible with the medicine. Pills must not be too large. One should not contain more than three or four grains of a vegetable, or five or six of a mineral substance. Sometimes they are coated with sugar or gelatin, to disguise their disagreeable taste.

PULVERES (*Powders*).—Medicines which are not too bulky, too disagreeable, nor too acrid, may be exhibited in this form. Oily or deliquescent substances are unfit for administration in this way. Efflorescent salts may be prepared by heating. Powders may be prepared by means of the mortar and pestle and subsequent sifting, or by precipitating the substance from its solution. Sometimes *levigation* and *elutriation* are practised.

Levigation is the rubbing of the moistened material between two hard flat stones. In practising elutriation, the powder is agitated in water, the coarser portions allowed to subside, the supernatant liquid poured off and allowed to settle, and the fine powder thus obtained is dried. The objection to powders is their liability to deterioration and adulteration. They may be administered in syrup, or dry, in sugar.

TROCHISCI (*Troches—Lozenges*).—Little tablets which are intended to be slowly dissolved in the mouth. They are especially used for their local impression upon the mouth and fauces. They are generally made with tragacanth and sugar. Gum arabic may be used, but it dissolves more rapidly than gum tragacanth.

CONFECTIONES (*Confections*)—Soft solids made with sugar.

EXTRACTA (*Extracts*) are prepared by evaporating either the expressed juice; decoction, or infusion (watery extracts); or the tincture (alcoholic extracts). They are usually administered in pills.

RESINÆ (*Resins*).—These are the active resinous principles of drugs, obtained by precipitating their tinctures with water. There are but three of them officinal—resins of scammony, podophyllum, and jalap; all purgatives.

SUPPOSITORIA (*Suppositories*).—These, now officinal[3] in the United States Pharmacopœia, are very important. They are little cones made of some substance which melts at the temperature of

[1] Deliquescent (*liqueo*, I flow—*de*, down) salts are such as absorb water from the air and melt in it.

[2] Efflorescent (*effloresco*, I flower) salts are such as give off their water of crystallization and are converted into a loose powder.

[3] *Official* is the more correct term, though not so commonly employed.

the body, intended to be inserted into the rectum. They are usually made of cocoa butter, and wax.

UNGUENTA (*Ointments*).—Soft solids, melting at or near the temperature of the body, intended to be used by inunction.

CERATA (*Cerates*).—Moderately soft substances, intended for external application, capable of being spread at ordinary temperatures, but not melting with the heat of the body. They usually contain wax.

EMPLASTRA (*Plasters*).—Solid substances, becoming more or less viscid at the temperature of the body, spread on muslin, skin, linen, or some similar material, and designed for external application.

CATAPLASMA (*Poultices*).—These are not officinal in the U. S. P. They are soft, very moist plasters, which are intended to relax the parts to which they may be applied. The most ordinary materials of which they are made, are flaxseed meal, mush, bread and milk, ground slippery elm bark, etc.

CHARTÆ (*Papers*).—Medicated papers for external application, now officinal, are the *Charta Cantharidis* and *Charta Sinapis*. Brief immersion in warm or tepid water should precede the use of the paper, either of cantharides or of mustard.

LIQUIDS.

DECOCTA (*Decoctions*).—Watery preparations of crude vegetable substances, made by boiling. Drugs which contain much starch, mucilage, or whose activity depends on some volatile substance, are not suitable for exhibition as decoctions. Watery preparations (except mixtures) of any drug, whose activity depends upon an oily, resinous, or other principle insoluble in water, are of course ineligible.

INFUSA (*Infusions*).—Watery preparations of crude vegetable substances, made with either cold or hot water, without boiling. Cold water is preferable, when the active principle is volatile, or there exists in the crude drug starch, or other inert substance, soluble at a high temperature, but not at a low one. Infusions may be made by *maceration*, *percolation*, or *displacement*. In maceration, the drug is allowed to soak in the menstruum for some days. In percolation the water is made to percolate, or run through, a mass of the material. Displacement is founded upon the fact that when a powder is saturated with a liquid, the latter may be forced out of it by adding more of the same liquid, which displaces the former. The powdered drug is packed in a cylinder, upon a perforated diaphragm, and an amount of water is added sufficient to thoroughly wet it. After a time more water is poured upon it, which displaces the first; this process is repeated again and again, until the drug is exhausted.

LIQUORES (*Solutions*).—Solutions in water of non-volatile substances (Liquor Calcis).

AQUÆ (*Waters*).—Solutions in water of volatile substances (Aqua Chlorini). When waters are impregnated with a volatile oil, they are usually made by first rubbing up the oil with carbonate of magnesium, and then with the water, and filtering.

Misturæ (*Mixtures*).—These consist of one or more insoluble substances suspended in water by means of gum, or some similar material. When the dissolved principle is an oil, the mixture is called an *emulsion*. Mixtures of assafœtida and other gum-resins are made by simply rubbing them up with water, the gum holding the resin in solution.

Mucilagines (*Mucilages*).—Aqueous solutions of gummy or mucilaginous substances.

Linimenta (*Liniments*).—Oily or soapy solutions, intended for external use, generally rubefacients.

Enemata (*Enemas. Clysters—Injections*).—These are liquid preparations for injection into the rectum. They are not officinal in the U. S. P.

Tincturæ.—Tinctures are alcoholic solutions of non-volatile substances. Strong alcohol is generally preferred, where the substance is entirely insoluble in water (as a resin), but diluted when this is not the case.

Spiritus (*Spirits*) are alcoholic solutions of volatile substances (Spiritus Camphoræ).

Vina (*Wines*).—These are solutions in *sherry wine*.

Oleoresinæ (*Oleoresins*).—Concentrated semi-solid preparations, consisting of a resin and volatile oil combined. They are obtained by evaporating an ethereal solution of the crude drug.

Olea Destillata (*Distilled Oils*).—Volatile oils obtained by distillation.

Extracta Fluida (*Fluid Extracts*).—These are concentrated fluid preparations, in most instances of such a strength that a fluidounce represents a troyounce of the crude drug. They are generally made by evaporating a tincture or infusion; sugar frequently being added as a preservative.

Succi (*Juices*).—Very concentrated preparations, of which two only are officinal in the U. S. Pharmacopœia; *Succus Conii* and *Succus Taraxaci*. Each of these is made by the addition to every five measures of the fresh juice, of one measure of alcohol.

Syrupi (*Syrups*).—Preparations in which there is sufficient sugar to form a dense viscid fluid.

Mellita (*Honeys*).—Solutions in honey. The only officinal (U. S. P.) are Mel Rosæ and Mel Sodii Boratis.

Aceta (*Vinegars*).—Solutions in vinegar. The only officinal (U. S. P.) are, Acetum Sanguinariæ, Opii, Lobeliæ, Scillæ.

Glycerita (*Glycerites* or *Glyceroles*).—Solutions in glycerin. Five such preparations are now officinal; those of Carbolic Acid, Gallic Acid, Tannic Acid, Tar, and Borate of Sodium.

The weights of the U. S. Ph. are derived from the Troy Pound. They are as follows:—

The pound ℔	contains	twelve ounces, ℥ = 5760 grains.
The ounce		eight drachms, ʒ = 480 grains.
The drachm		three scruples, ℈ = 60 grains.
The scruple		twenty grains, gr.

The measures of the U. S. Ph. are derived from the Wine Gallon. They are as follows:—

The gallon (C) The pint The fluidounce The fluidrachm	contains	eight pints, O. sixteen fluidounces, f℥. eight fluidrachms, fʒ. sixty minims, ♏.

A *drop* and a *minim* are not necessarily the same. For *water*, they are nearly so; but the drops of *tinctures* are smaller. Of laudanum 2 drops are equal to 1 minim.

The imperial or avoirdupois weights and measures used in the British Pharmacopœia are as follows:—

WEIGHTS.

1 pound	lb.	=	16 ounces	=	7000 grains.
1 ounce	oz.	=	. . . . .	=	437.5 grains.
1 grain	gr.	=	. . . . .	=	1 grain.

MEASURES.

1 gallon	C.	=	8 pints	Oviij.
1 pint	O.	=	20 fluidounces	fl. oz. xx.
1 fluidounce	fl. oz.	=	8 fluidrachms	fl. drs. viij.
1 fluidrachm	fl. drm.	=	60 minims	min. lx.
1 minim	min.	=	1 minim	min. j.

At 60° F., a pint of distilled water (imperial measure) weighs 8750 grains.

METRICAL WEIGHTS.

Metrical Weights.	*Exact Equivalent in Grains.*	*Approximate Equivalent in Grains.*
1 Milligramme	.0154	$\frac{1}{65}$
1 Centigramme	.1543	$\frac{1}{6}$
1 Decigramme	1.543	$1\frac{1}{2}$
1 Gramme	15.434	gr. xv.
1 Decagramme	154.340	ʒijss.
1 Hectogramme	1,543.402	℥iij ℈v.
1 Kilogramme	15,434.023	℔ij ℥viij.

APPROXIMATE MEASURES.

One teaspoonful	=	fʒj.
One tablespoonful	=	f℥ss.
One wineglassful	=	f℥ij.

CLASSIFICATION OF MEDICINES.

It is evident that some classification of medicines must be made, would we study them to advantage, either as individual entities or in their relations one to the other; and, also, that such classification may be a mere arbitrary arrangement, or may be founded on the relations of the properties of medicines. The former sort of classifications are sometimes called the *empirical;* as an example, may be cited the *alphabetical arrangement*, adopted in the U. S. Pharmacopœia. Of the second set of classifications—the so-called *rational classifications*—the two which have attracted the most attention are: 1. That which groups them in accordance with the natural relations of the animals, plants, and minerals which produce them, the so-called *natural history classification.* 2. That which arranges them in accordance with their action on the human

system—the so-called *physiological classification.* There are several of these classifications in vogue, but as they are after all merely pegs to hang our ideas on, it is not worth while to discuss more than one of them. The one adopted in this manual is that of Prof. Geo. B. Wood, as modified, and at present taught, by Prof. Carson, of the University of Pennsylvania. In it medicines are first divided into those which act upon the solids and fluids of the body, and those which act on foreign substances in the body. The latter class includes only two subdivisions—the *antacids*, or medicines which neutralize acid in the system; and *anthelmintics*, medicines which kill worms and expel them from the alimentary canal. The former class is divided into two great sub-classes: 1. GENERAL REMEDIES. 2. LOCAL REMEDIES. 1. Substances which exert an influence on the system, acting through the medium of the circulation or through the nervous system. They are divided into three orders: *Stimulants*, which elevate the functions generally above the natural standard; *sedatives*, which depress them below the natural standard; *alteratives*, which slowly change nutrition, and thereby supersede diseased action.—Stimulants are again divided into *permanent s.* and *diffusible s.*; the former of these includes *astringents* which excite the vital contractility, and *tonics* which increase the amount of vital contractility in the system, giving tone to it. Diffusible stimulants include the two divisions, *arterial s.* and *cerebro-nervous s.*, the latter being subdivided into *cerebral*, *nervous*, and *excito-motor* stimulants. Sedatives include only two ultimate divisions: *arterial* and *nervous sedatives.* It is in the distribution of agents which act upon the brain and nervous system, that the greatest difficulties of classification exist, and the arrangement adopted continues to be to some extent inexact.

LOCAL REMEDIES are divided: 1. Into those which affect *functional activity.* 2. Those which affect the *structure of a part.* 3. Those which act *mechanically.* 1. Divided into *emetics*, which cause vomiting; *cathartics*, which purge; *diuretics*, which increase the urine; *diaphoretics*, which increase perspiration; *expectorants*, which increase the secretion from the lungs; *emmenagogues*, which increase the menstrual flow; *sialagogues*, which increase the salivary secretions; *errhines*, which increase the nasal secretions. 2. Medicines affecting structure are divided into *rubefacients*, which irritate and inflame the skin; *epispastics*, which vesicate the skin; *escharotics*, which produce the death of the part to which they are applied. 3. Local remedies which act mechanically are: *demulcents*, which protect the surfaces to which they are applied from irritation; *emollients*, which soften and relax the skin; *diluents*, which dilute the secretions.

TABLE OF CLASSIFICATION.

I. Substances which act upon the Solids and Fluids of the Body.

General Remedies.	Stimulants.	Permanent.	Astringents, Tonics.	
		Diffusible.	Arterial.	
			Cerebro-nervous.	Cerebral, Nervous, Excito-motor.
	Sedatives.	Arterial or Refrigerants,		
		Nervous.		
Local Remedies.	Affecting functions.	Emetics, Cathartics, Diuretics, Diaphoretics, Expectorants, Emmenagogues, Sialagogues, Errhines.		
	Affecting structure.	Rubefacients, Epispastics, Escharotics.		
	Mechanical.	Demulcents, Emollients, Diluents.		

II. Substances which act on Foreign Substances in the Body.

Antacids,
Anthelmintics.

CHAPTER IV.

ASTRINGENTS.

Astringents are substances which can cause contraction and consequent increase of the firmness and density of living tissue, without impairing its vitality. They act dynamically and chemically. Most of them are capable of coagulating albumen out of the body; but it is evident that they can do this but to a very limited extent when applied to living tissue, else they would cause death, and act as *caustics* rather than as astringents. In many instances they exert their power after being absorbed into the blood; and if they acted chemically on the tissues, coagulating their albumen, they would first coagulate the albumen of the blood. They cannot therefore act *chemically* to any great extent. Almost all living tissue is endowed with contractility, *i. e.*, with

the power of drawing its particles nearer together under the influence of appropriate stimuli, and such stimuli are astringents. Very many substances are astringents, when locally applied, which possess other medical properties in so much greater a degree, that when taken into the blood their astringent effects are entirely lost in some other overwhelming impression. Such is alcohol. There are many astringents that are powerfully tonic; indeed the line between these two classes it is very difficult to draw. Thus sulphuric acid taken internally acts both as tonic and astringent. There are therefore many officinal astringents which are not included in the following, and must be looked for under other heads. The most obvious effect of astringents, when locally applied, is shrinking and increased pallor of the part; when taken internally, diminution of secretion and contraction of the capillary vessels. They are used locally to produce contraction of abnormally relaxed parts, to overcome local passive congestion of the smaller vessels, and to arrest profuse secretions. They are administered internally to arrest profuse hemorrhagic or other discharges, as in hæmoptysis, leucorrhœa, diarrhœa, night sweats, etc. They must never be used in either way when there is acute inflammation, as they then act simply as irritants; but when the acute stage is past they are very useful. Thus, in the early stage of dysentery they are generally to be avoided, but afterwards they may be exhibited with benefit.

They are divisible into two classes, the vegetable and the mineral astringents.

VEGETABLE ASTRINGENTS.

Acidum Tannicum. *Tannic Acid.*

The active principle of *all* the vegetable astringents. Obtained from galls, by the action of washed ether. Whitish, feathery, very light powder, with an astringent, bitterish taste, and slight peculiar odor. Precipitates solutions of gelatin, albumen, alkalies and their carbonates, vegetable substances containing alkaloids (as opium), forming tannates. Freely soluble in water, less so in alcohol. Two varieties—(*a*) Gallo-tannic and (*b*) kino-tannic acid.

(*a*) Exists in galls, oak-bark, etc.; strikes a *bluish*-black color with *persalts of iron.* Converted by oxidation into gallic acid; the officinal variety.

(*b*) Exists in kino, catechu, etc.; generally associated with a red coloring matter; strikes a *greenish*-black with persalts of iron. Converted by oxidation into an insoluble apothema.

Incompatibles.[1]—Alkalies and their carbonates, alkaloids and vegetable substances containing them, mineral acids, iron salts, etc.

Therapeutics.—Purely astringent. Useful in diarrhœas, hemorrhages from the stomach and bowels; is thought to be converted into gallic acid before entering the blood. Dose, gr. v–xx, in pill or solution.

[1] All the vegetable astringents have of course the same incompatibles. These are therefore not again alluded to in the text.

Unguentum Acidi Tannici. Ointment of Tannic Acid.—Strength, 30 grs.–℥j. Used for hemorrhoids, etc.

Glyceritum Acidi Tannici. Glycerite of Tannic Acid.—Strength, ℥ij in Oss of glycerin. An excellent preparation for local application; as in leucorrhœa, etc. It will sometimes bear dilution with water.

Acidum Gallicum. *Gallic Acid.*

Obtained by exposing gallo-tannic acid to air. In minute acicular crystals, whitish. Sparingly soluble in cold water; freely in hot water and alcohol. Produces deep bluish-black color with persalts of iron. Does not precipitate with gelatin.

Therapeutics.—Preferred to tannic acid in hemorrhages from remote organs, to which access is to be had only through the blood (as in hæmaturia, hæmoptysis, etc.), as it is believed to enter that fluid more readily. Dose, gr. v–xx, in powder or pill.

Galla. *Nutgalls.*

Morbid excrescences produced upon the gall oak of Syria and Asia Minor (Quercus infectoria) by the puncture of an insect (Cynips quercusfolia). Roundish, irregularly tuberculated, ½ to 1½ inch in diameter. Taste, astringent, bitterish. Two varieties—(*a*) white, (*b*) blue.

(*a*) Very light. Hollow, with a hole in each made by the insect in eating his way out. Whitish color.

(*b*) Heavier and more solid. No hole, the insect still in. Smaller, less mature, but more valuable. Bluish color.

Therapeutics.—Pure astringent. Seldom used except for manufacture of tannic acid. Dose, gr. x–xx, in powder.

Tinctura Gallæ. Tincture of Nutgalls.—Strength, ℥ij–Oj. Used as a test, and as a gargle in relaxed fauces, etc.

Unguentum Gallæ. Ointment of Nutgalls.—Strength, ʒj, lard ℥vij; used as a local astringent.

Quercus Alba. *White Oak.*

Inner bark of the indigenous white oak. Whitish. Taste, peculiar and astringent. Odor, feeble and peculiar.

Therapeutics.—Astringent, rarely used internally, but as a local application.

Decoctum Quercus Albæ.—Strength, ℥j to Oj. Useful in leucorrhœa, flabby ulcers, etc., as a wash.

Quercus Tinctoria. *Black Oak.*

Inner bark of the indigenous black oak. Reddish-brown. Used in dyeing under name of Quercitron.

Therapeutics.—Same as last. Stains the linen.

Catechu. *Catechu.*

Obtained by evaporating a decoction of the heart-wood of the Acacia catechu, a native of India. Occurs in masses or fragments of a dull, dark, reddish-brown color, short resinoid fracture, and peculiar astringent taste. The finest specimens are more shining, and closely resemble kino. There are several non-officinal varieties. Pale catechu, which occurs in small cubes, is obtained from the *Uncaria gambir*. *Terra Japonica* is an inferior variety of this,

extensively used in the arts. Catechu contains catechuic acid, a variety of kino-tannic acid.

Therapeutics.—A simple, powerful astringent.

Infusum Catechu Compositum. Compound Infusion.—Catechu, ℥ss; Cinnamon, gr. 60; Boiling water, Oj. Used in chronic diarrhœa. Dose, f℥ss–f℥j.

Tinctura Catechu.—Strength, catechu, ℥iij; Cinnamon, ℥ij; Dilute alcohol, Oij. Does not gelatinize so readily as tr. kino. Dose, fʒj–fʒij.

Kino. *Kino.*

The inspissated juice of the Pterocarpus Marsupium, a tree which grows in the East Indies. The juice is obtained by making longitudinal incisions through the bark, and is then carefully dried. Besides the ordinary kino, the East Indian, there are three varieties: 1, African, derived from the Pterocarpus erinaceus; 2, West Indian or Jamaica, from the Coccaloba uvifera; 3, Botany Bay kino, from the Eucalyptus resinifera. These are at present very rarely if ever seen in our markets. East Indian kino occurs in angular brittle fragments of variable size, of a dark-red color, with a resinous shining surface. The taste is peculiar and astringent. Yields to water and alcohol. Contains *kino-tannic* and *kinovic acids* (red coloring matter, kinic red).

Therapeutics.—Pure astringent. Dose, gr. x–xx.

Tinctura Kino. Tincture.—Strength, ℥iss–Oj. Should be recently prepared; apt to gelatinize and become inert. Dose, fʒj–ij.

Krameria. *Rhatany.*

Root of Krameria triandra, a native of west coast of South America. Diameter, from one-fourth to an inch. Length, from a few inches to several feet. Sometimes simple, sometimes much branched. The bark is reddish-brown, easily separable; in it most of the virtues of the root reside. Wood, reddish; taste, astringent; odor, very slight. Contains *kino-tannic* and *krameric acids.*

Therapeutics.—Powerfully astringent and slightly tonic. Never given in substance.

Infusum Krameriæ. Infusion.—Strength, ℥j–Oj cold water. Dose, f℥j–f℥iij.

Extractum Krameriæ. Extract.—Made by evaporating cold infusion. Dose, gr. x–xx, in pill or powder.

Tinctura Krameriæ. Tincture.—Strength, ℥iij–Oj, dilute alcohol. Dose, fʒj–fʒiij.

Syrupus Krameriæ. Syrup.—Extract of rhatany, ℥ij; Sugar, ℥xxx; Water, Oj. An elegant astringent in the bowel complaints of children. Dose, fʒij–f℥ss.

Hæmatoxylon. *Logwood.*

The heart wood of the Hæmatoxylon Campechianum, a native of Central America. A very dense, heavy, hard wood of a dark reddish color and sweetish astringent taste. Contains tannin (blue black variety) and *hæmatoxylin* or *hematin.* The latter is the crystallizable coloring principle.

Therapeutics.—A mild, unirritating astringent. Never given in substance.

Decoctum Hæmatoxylon. Decoction.—Strength, ℥j–Oj. Dose, f℥j–f℥iij.

Extractum Hæmatoxyli. Extract.—Made by evaporating decoction. A very dark, hard extract, whose sweetish taste peculiarly fits it for administration to children.

Dose, gr. v–xx. Should be given in solution.

Geranium. *Geranium.*

The rhizoma of Geranium maculatum, an indigenous plant, flowering in June, with large purple, often spotted, flowers, growing to a height of from one to two feet. Occurs in grayish pieces two to three inches long, one-fourth to one-half inch thick, much wrinkled and tuberculated, often with numerous rootlets. Taste, astringent. Contains gallo-tannic acid.

Therapeutics.—Our best native astringent. For administration to children, gr. v–x in half a tumblerful of milk, given as often as necessary. Dose for adult, gr. x–xx, in infusion.

Rubus. *Blackberry.*

The root of Rubus Canadensis (Blackberry), and R. villosus (Dewberry). The bark, in which resides all the virtue, is grayish-brown. Contains gallo-tannic acid.

Therapeutics.—A mild astringent. Dose, gr. x–xxx, in infusion or decoction.

Uva Ursi. *Uva Ursi.*

The leaves of the Arctostaphylos uva ursi (Bearberry), a native of Northern Europe and America. Leaves thick, leathery, wedge-shaped, 1 to 1½ inch long, with entire margins, and smooth upper, reticulated lower surface. Odor, hay-like. Taste, peculiar, somewhat aromatic, bitterish, and astringent. Yields to water and alcohol. Contains gallo-tannic acid, bitter extractive, and *ursin*, a peculiar, crystallizable, powerfully diuretic principle.

Fig. 240.

Arctostaphylos Uva Ursi.

Therapeutics. — Astringent and tonic, with a tendency to act on the kidneys. Used in cases of chronic cystitis, cystorrhœa, stone, etc., when an astringent, soothing action on the bladder is desired, as well as in chronic nephritis. Its astringent principle has been detected in the urine. Dose, gr. xx–xxx, t. d., in powder or infusion.

Decoctum Uvæ Ursi. Decoction.—Strength, ℥j–Oj. Dose, f℥ii–iij.

Extractum Uvæ Ursi Fluidum. *Fluid Extract.*—Dose, f℥j.

Chimaphila. *Pipsissewa.*

The leaves of the Chimaphila pipsissewa, a small indigenous evergeen plant, with thick, dark-green leaves clustered at the top of the stem; height 2 to 3 inches; leaves, wedge-lanceolate, of a uniform green color; serrate. Contain bitter extractive, tannin, etc.

Fig. 241.

CHIMAPHILA UMBELLATA.

Therapeutics.—Tonic and astringent. Has been recommended in scrofula, and chronic nephritic and cystic disorders.

Decoctum Chimaphilæ. Decoction.—Strength, ℥j–Oj. Dose, f℥j–iij t. d.

Rosa Gallica. *Red Rose.*

Petals of Rosa gallica, a native of Europe. Contain tannin and volatile oil.

Therapeutics.—Mild astringent. Used chiefly as an elegant adjunct and vehicle.

Infusum Rosæ Compositum. Compound Infusion.—Red rose, ℥ss; Diluted sulphuric acid, f℥iij; Sugar, ℥iss; Water, Oijss. Refrigerant and tonic. Color, beautiful red. Also *Confection of Roses* (used principally in making pills); *Honey of Rose—Syrup of Red Rose*, both used only as vehicles.

Rosa Centifolia. *Hundred-leaved Rose.*

Petals of Rosa centifolia. Contain volatile oil, no tannic acid. Not astringent.

Aqua Rosæ. Rose Water.—Strength, ℥iij–Oj. Used as an elegant vehicle in collyria (eye-washes), etc.

Unguentum Aquæ Rosæ. Ointment. Cold Cream.—Oil of sweet almonds, f℥iijss; Spermaceti, ℥j; White wax, gr. cxx; Rose water, f℥ij. An elegant soothing and protective application to excoriations, etc.

Granati Fructus Cortex. *Pomegranate Rind.*

Granati Radicis Cortex. *Bark of Pomegranate Root.*

The product of Punica granatum. Pomegranate rind occurs in sections or fragments, thicker and denser than dried lemon-peel, which it resembles. It has an astringent, bitterish taste. Both contain largely of gallo-tannic acid, as do also the flowers.

Therapeutics. The rind is a pure astringent. Dose, gr. xx, in decoction. The root bark is employed as a vermifuge in cases of tapeworm; it generally nauseates, and purges slightly. It should be given in decoction, ℥j–Oj. Dose, f℥j.

The root of the Potentilla tormentilla and the unripe fruit of the Persimmon (Diospyros Virginiana) are also officinal under the names of *Tormentilla* and *Diospyros*. They are simple astringents.

Creasotum. *Creasote.*

This is a product of the distillation of wood-tar. It is a colorless, oily liquid, a little heavier than water. Its odor is strong and peculiar; taste, very pungent. It is *caustic* in its action on the mouth or skin. Boiling point, 426° F. When strongly heated, it burns with a smoky flame. It coagulates albumen. It is neutral to test-paper; is soluble in caustic potassa, and dissolves resins, fats, camphor, and the volatile oils. Carbolic acid is frequently sold for it in the shops.

Physiological and Therapeutical Effects.—Taken internally in large amount, creasote is a powerful irritant poison. Applied externally, it whitens and destroys the skin. Taken in moderate amount, diluted, into the stomach, it often acts as a diuretic; its characteristic odor being perceived in the urine. More largely

given, it may cause strangury. Medicinally, creasote is most useful in relieving obstinate vomiting, and in checking hemorrhage, especially from the stomach or bowels. Dose, 1 drop, in aromatic water or mucilage.

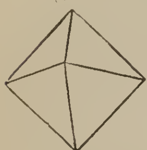
Aqua Creasoti. Creasote Water.—Strength, fʒj in Oj; *Unguentum Creasoti. Ointment*, fʒss in ℥j of lard.

MINERAL ASTRINGENTS.

Aluminii et Potassii Sulphas. *Potassa Alum.*

The sulphate of aluminium and potassium occurs in colorless octohedral crystals, slightly efflorescent, inodorous, of sweetish astringent taste. It is found mixed with impurities in alum stone in Italy, and is also largely manufactured from alum slate, a mixture of bisulphuret of iron, alumina, and various substances. This is exposed to air, then stratified with wood, and set on fire. The sulphur is oxidized into sulphuric acid, unites with the alumina and with the potassa of the wood ashes, and forms the salt, which is purified by solution and crystallization. The iron is converted into the sesquioxide and set free. Soluble in water; insoluble in alcohol. Solution precipitated by ammonia and potassa; coagulates albumen.

Fig. 242.



Incompatibles.—Alkalies and carbonates; lime-water; magnesia and its carbonate, acetate of lead.

Therapeutics.—A powerful, somewhat irritant astringent. In teaspoonful doses, a stimulating emetic. Its principal use is as a local application; seldom used internally. It has been strongly recommended in colica pictonum in 5 gr. doses. It may be given as alum whey, made by boiling ʒij in a pint of milk, and straining. Dose, fʒij.

Alumen Exsiccatum. Dried Alum.—When alum is heated, its water of crystallization is driven off, and it is changed into a white powder. This is a very mild caustic, used to diminish exuberant granulations.

Alumen. *Ammonia Alum.*

Physical properties precisely those of last. The ordinary alum of the shops. Potassa and a little water cause it to evolve the odor of ammonia.

Therapeutics.—Same as last.

Aluminii Sulphas. *Sulphate of Aluminium.*

A white powder, or in lamellar crystals.

Therapeutics.—Used externally as an astringent, antiseptic, detergent application. In saturated solution slightly caustic. Sometimes used to preserve bodies for dissection.

Plumbum. *Lead.*

Mostly obtained from galena (sulphide of lead). The salts of lead unite sedative powers to great astringency. Their sedative

properties enable us to use them earlier in inflammations than the other astringents; indeed the acetate is used as a local application even during the height of inflammation, and is often useful in cases of dysentery when other astringents would aggravate. The protracted use of almost any salt of lead produces chronic lead poisoning, *colica pictonum*, characterized by very obstinate constipation, with twisting umbilical pain, knotted abdominal muscles, loss of appetite; soon followed by paralysis and great atrophy of the extensors. This affection occurs as the result of the use of water, cider, wine, etc., contaminated with lead, and is often seen in those exposed to the vapors of lead, as solderers, white lead makers, etc. Iodide of potassium is said to act as a specific, causing the lead to be eliminated. Special symptoms should be appropriately combated. The soluble salts of lead in over-dose act as irritant poisons. Sulphuric acid, or some soluble sulphate, should be given early, as the antidote, forming the totally insoluble sulphate of lead. For the same reason, dilute sulphuric acid has been recommended as a prophylactic drink against the chronic poisoning.

Plumbi Oxidum Semivitreum. *Litharge.*

Obtained by exposing melted lead to air. A heavy, tasteless, insoluble flesh-colored, scaly powder.

Emplastrum Plumbi. Lead Plaster.—Made by decomposing olive oil by litharge, the oleo-palmitate of lead being formed and *glycerin* set free. Used as a protective application, and as the basis of most plasters.

Plumbi Carbonas. *Carbonate of Lead. White Lead.*

Made by exposing lead to fumes of vinegar in pots covered with decomposing manure. A subacetate is first formed, which is decomposed by the carbonic acid from the manure. A white, inodorous, insoluble powder, soluble in water containing CO_2, very poisonous when taken internally for any length of time.

Therapeutics.—Used as a local desiccant and sedative.

Unguentum Plumbi Carbonatis. Ointment.—Gr. xxx–ʒj to an ounce of lard.

Plumbi Acetas. *Acetate of Lead. Sugar of Lead.*

Obtained by dissolving the oxide or carbonate in distilled vinegar. In small acicular, colorless, efflorescing crystals, of a sweet, astringent taste and peculiar odor, very soluble in water.

Incompatibles.—Mineral acids, alkalies, alkaline earths, and carbonates; tannic acid. Opium is chemically, but not therapeutically incompatible (the meconate of lead is precipitated).

Therapeutics.—Used internally in internal hemorrhages, diarrhœa, in dysentery, cholera infantum. Externally, as a sedative application in inflammation; to a mucous membrane, the strength of solution may be gr. j–iv in f℥j; to skin, gr. x–xx in f℥j of water; often very usefully combined with opium, both for general and local use. Dose, gr. j–iv.

Liquor Plumbi Subacetatis. *Solution of the Subacetate of Lead. Goulard's Extract.*

Made by boiling litharge and acetate of lead together. Its chemical constitution varies. A transparent fluid of a sweetish astringent taste and alkaline reaction. By exposure, absorbs carbonic acid from the air, and precipitates carbonate of lead, an acetate being left in solution. Should therefore be kept in closely stopped bottles.

Incompatibles.—Those of acetate, also gum arabic and starch.

Therapeutics.—Used only as a local sedative application, must be diluted.

Liquor Plumbi Subacetatis Dilutus. Dilute Solution. Lead Water.—Strength, f℥ij–Oj of water.

Ceratum Plumbi Subacetatis. Goulard's Cerate.—Contains the solution, with white wax, olive oil, and camphor. An excellent soothing application to ulcers and inflamed skin.

Plumbi Nitras. *Nitrate of Lead.*

Made by dissolving litharge in nitric acid. Basis of *Ledoyen's Disinfectant Solution.* Decomposes sulphuretted hydrogen.

Plumbi Iodidum. Iodide of Lead.—Bright yellow powder; used as resolvent, for chronic inflammations and tumors.

Cuprum. *Copper.*

In over-doses the salts of copper act as irritant poisons; the best antidote is albumen, followed by castor oil, to carry off the compound formed. In small doses slightly tonic and astringent, with a reputed tendency to act on the nervous system. Locally astringent, and stimulant.

Cupri Sulphas. *Sulphate of Copper. Blue Vitriol.*

Occurs in blue, efflorescent rhomboidal prisms, of a strongly metallic and styptic taste. Very soluble in water, insoluble in alcohol. When heated, melts in water of crystallization, then becomes a white powder, afterwards fuses.

Incompatibles.—Tannic acid, alkalies, and their carbonates.

Therapeutics.—Used in chronic diarrhœa and dysentery, in $\frac{1}{4}$–$\frac{1}{2}$ grain doses. In iij–v grain doses a very prompt stimulating emetic, especially adapted to cases of opium poisoning. In larger quantity an irritant poison.

Used locally, in solid form, as a very mild caustic and stimulant to flabby granulations, in solution (gr. x–xx, f℥j), as a stimulant to ulcers, etc. (Gr. $\frac{1}{2}$–1, f℥j) as a collyrium in chronic conjunctivitis.

Cuprum Ammoniatum. *Ammoniated Copper.*

Made by adding carbonate of ammonium to the sulphate. Color, very deep blue. Supposed to have a tonic action on nervous system; has been recommended in epilepsy, hysteria, chorea, etc. Dose, gr. iij, t. d.

Zincum. *Zinc.*

Found in nature principally as silicate, sulphide (zinc blende), and carbonate (calamine).

Zinci Oxidum. *Oxide of Zinc.*

Obtained as a sublimate by burning the metal. White, inodorous, tasteless, insoluble powder. Dissolved by acids, salts being formed.

Therapeutics.—Locally desiccant; feebly astringent and stimulant. Used to reduce discharges, facilitate healing of flabby ulcers, etc. Internally, slightly tonic. Dose, gr. ij.

Unguentum Zinci Oxidi. Ointment.—Strength, gr. lxxx to ℥j lard. Employed in skin diseases.

Zinci Sulphas. *Sulphate of Zinc. White Vitriol.*

Obtained by putting zinc in dilute sulphuric acid. Occurs in small, four-sided, prismatic crystals (very like Epsom salts), slightly efflorescent, of a strong metallic styptic taste. Soluble in water, insoluble in alcohol. By heat, they dissolve in their water of crystallization, and then become a white powder.

Incompatibles.—Alkalies, alkaline earths, and their carbonates; soluble salts of lead, lime, baryta; sulphuretted hydrogen, tannic acid, etc.

Therapeutics.—Astringent and stimulant locally; internally, in small doses (gr. ½–ij), tonic; in large doses (gr. xx–xl), a powerful, stimulant emetic, not so irritant as sulphate of copper. Used in conjunctivitis (gr. j–iij–f℥j) and other subacute inflammations.

The *Acetate of Zinc*, made by adding oxide of zinc to acetate of lead; also officinal. Used only topically. Its strength and action are identical with those of the last. *Precipitated Carbonate of Zinc* is officinal; its action and use are similar to those of the oxide. There is a cerate of it (strength ℥j–℥v).

Liquor Potassii Permanganatis. *Solution of Permanganate of Potassium.*

A deodorizing, disinfectant liquid, supposed to owe its properties to the escape of oxygen, in the condition of ozone. It is used especially as a mouth wash or gargle; in *cancrum oris, diphtheria*, etc.

Liquor Sodæ Chlorinatæ. *Solution of Chlorinated Soda.*

An admirable disinfectant and deodorizer. Employed in dilute solution as a wash for gangrenous sore mouth, malignant diphtheria, etc. It may be diluted with water or glycerin; from f℈ss to f℈ij in f℥ij of the diluent liquid.

CHAPTER V.

TONICS.

THESE are substances which, when properly administered, very gently and persistently stimulate the human system, especially nutrition and the blood-making functions; increasing the vigor of the whole frame, giving tone to the enfeebled organs, and raising the depressed system towards health.

Astringents call into action any existent contractility in a part and thus render it firmer; tonics produce increased firmness, by increasing the contractility in the part. Stimulants differ from tonics; they call into action existent power, whilst tonics increase that power. The former are used when it is desired to counteract some depressing cause, or to goad on a flagging system; the latter, when it is desired to build up and strengthen permanently. Stimulants are like the blast that increases the fire and makes it burn faster—tonics, like the fuel which increases it slowly but surely by feeding it. Vegetable tonics are divisible into the simple bitters, stimulating tonics, aromatics, and the peculiar bitters. The first simply increase nutrition and digestion—the latter do this and have also some other action on the economy. Thus, wild cherry bark is a tonic, but it is also a sedative owing to its hydrocyanic acid; whilst in quinine we have a simple principle which unites in itself the properties of a pure bitter, nervine, and antiperiodic. Bitterness is a universal character of vegetable tonics, unless we consider the aromatics as such. The great indication calling for the use of a simple bitter is the *want of appetite*, in the absence of any acute inflammation or febrile condition of system and of general plethora, or organic stomach affection. They are pre-eminently *appetizers.*

Thus they are useful during convalescence from acute disorders, in depressed digestion from over-study, exhausting discharges, etc. Stimulating tonics owe their power to the union of a bitter principle with a volatile oil. Aromatics are rather local and general stimulants than tonics, and have volatile oils for their active principles. They can only act as tonics by locally stimulating the digestive system.

SIMPLE BITTERS.

Quassia. *Quassia.*

Wood of a Jamaica tree, the Simaruba excelsa, also of a South American tree, Quassia amara. Light, yellowish, spongy, excessively bitter. Comes in billets three to five inches in diameter; but generally kept in shops in form of raspings. Contains bitter extractive (*quassin*) and a little tannin. Yields these to water and alcohol.

Therapeutics.—A powerful simple bitter, in large doses oppressing the stomach.

Infusum Quassiæ. Infusion (℥ij–Oj).—Dose, f℥j–ij.

Tinctura Quassiæ. Tincture (℥j–Oj).—Dose, f℥j–ij.

Extractum Quassiæ. Extract.—Made by evaporating infusion. Dose, gr. j–ij, in pill.

Simaruba.

Bark of a Jamaica tree, *Simaruba officinalis.* Similar in properties to quassia. Contains quassin.

Coptis. *Goldthread.*

The roots of the indigenous Coptis trifolia. Thin thread-like roots of a golden color, which they impart with their virtues to water, more freely to alcohol. Taste, bitter. Odor, none.

Therapeutics.—A pure bitter.

Fig. 243.

COPTIS TRIFOLIA.

Gentiana. *Gentian.*

The root of the Gentiana lutea, the yellow gentian of the Alps. Tapering, often branched: three to four inches long; wrinkled spirally; yellowish internally, grayish externally. Odor, peculiar, feeble. Taste, intensely bitter, slightly sweetish. Contains *gentisic acid*, gum, a peculiar sugar, and *gentianin*, the neutral crystallizable, bitter principle. Owing to the sugar, gentian is capable

of vinous fermentation, and the Swiss prepare an alcoholic drink from it. It may be used with iron, as it contains no tannin.

Therapeutics.—A pure, stimulating bitter.

Infusum Gentianæ Compositum. Compound Infusion.—Gentian, ℥ss; Bitter orange-peel, Coriander, āā gr. lx; Alcohol, f℥ij; Water, q. s. to make a pint. An elegant stomachic preparation. Dose, f℥j–ij.

Tinctura Gentianæ Composita. Compound Tincture.—Gentian, ℥ij; Bitter orange-peel, Cardamom, āā ℥ss; Diluted alcohol, Oij. Dose, fʒj–ij.

Extractum Gentianæ. Extract.—A watery extract. Dose, gr. iij–v, in pill.

Extractum Gentianæ Fluidum. Fluid Extract.—Made by evaporating tincture. Dose, fʒss–fʒj.

Calumba. *Columbo.*

The root of Cocculus palmatus, an herbal plant of Mozambique. Occurs in transverse slices, one to two inches in diameter. Starchy, whitish surface; bitter taste; spongy fracture; feeble odor. Yields to water and alcohol. Contains starch, albumen, *berberina*, combined with *colombic acid* and a peculiar neutral crystallizable principle, *calumbin;* no tannin.

Therapeutics.—A pure bitter, and stomachic.

Infusum Calombæ. Infusion (℥ss–Oj).—Made with *cold* water. Dose, f℥j–ij.

Tinctura Calombæ. Tincture (℥ij–Oj).—Diluted alcohol. Dose, fʒj–ij.

Eupatorium Perfoliatum. *Thoroughwort. Boneset.*

The herb of Eupatorium perfoliatum, an indigenous composite plant. Yields its properties to water.

Therapeutics.—In small doses tonic; in larger dose, in warm infusion, sudorific; in still larger quantity emetic. Used as a sudorific in "general colds," breakbone fever, etc. Not given in substance.

Infusum Eupatorii. Infusion (℥j–Oj).—Made with boiling water. Dose, as tonic, wineglassful t. d.; as diaphoretic, Oss–Oj; as emetic, *ad libitum.* The herb of *Sabbatia angularis*, and the root of *Frasera Walteri*, both indigenous plants, are also officinal. *Sabbatia* may be substituted for boneset. *Frasera* is a simple bitter.

PECULIAR BITTERS.

Prunus Virginiana. *Wild-cherry.*

The inner bark of the Prunus serotina, our indigenous wild-cherry. Occurs in light-brownish, irregular pieces, with a short fracture of a decidedly bitter, peach-leaf taste, and, when moistened, the odor of prussic acid. Contains gallo-tannic acid, bitter extractive, *emulsin* and *amygdalin.* When water is added to wild-cherry bark it reacts with the amygdalin, forming *hydrocyanic acid* and a volatile oil. The presence of emulsin is necessary, but it acts only catalytically, *i. e.*, by its presence. The bark does not yield its active properties to alcohol.

Therapeutics.—Tonic and sedative. It is used in phthisis, when it is desirable to increase the tone of the general system and diminish vascular action. It also, in pulmonary affections, quiets the cough, allaying nervous irritation. Heat must never be used in making preparations of it on account of the great volatility of the hydrocyanic acid, its sedative principle.

Infusum Pruni Virginianæ. Infusion (℥ss–Oj).—Made by displacement. Dose, f℥ij.

Syrupus Pruni Virginianæ. Syrup.—Dose, f℥ss. Used as a sedative vehicle in cough mixtures. It is a good mild expectorant.

Extractum Pruni Virginianæ Fluidum. Fluid Extract.—Prepared by first making concentrated tincture, which contains only the amygdalin and bitter extractive, then adding to this a strong watery solution of emulsion, from sweet almonds, when the characteristic reaction ensues. A very elegant preparation. Dose, f℥j–ij.

Cinchona. *Peruvian Bark.*

The bark of various species of Cinchona, from the western coast of South America, the most important of which are, C. condaminea, micrantha, cordifolia, calisaya. They never grow at a less elevation than 4000 feet, nor north of 11° north latitude, nor south of 20° south latitude. The name cinchona is derived from the Countess of Cinchon, the first person of note cured by it. The Jesuits were among the very first to introduce it into Europe, hence the name Jesuit's bark. Besides the officinal barks, there are numerous varieties of the Pitaya barks, which are imported from the northern coast of South America, and largely used in the manufacture of the alkaloids.

There are three varieties of the officinal barks: pale, yellow, red.

Cinchona Pallida. *Pale Bark.* (Loxa or Crown Bark.)

The product of C. condaminea, C. micrantha. Occurs in quills two to eighteen inches long, two lines to an inch in diameter, with grayish *adherent* epidermis. Color of bark, pale fawn to orange; fracture smooth; color of powder, pale fawn.

Cinchona Flava. *Yellow Bark.* (Royal Yellow Calisaya Bark.)

The product of C. calisaya. Occurs in quills or flat pieces. Quills from three inches to two feet in length, one-fourth to two inches in diameter. These are taken from the smaller branches. The flat pieces come from the large branches, quite flat or slightly curved. The epidermis is either *absent* or *loosely attached* in both forms. The fracture is fibrous, with projecting transparent spiculæ, which, on handling, separate from the bark and pierce the skin. Color, yellow, often with a tinge of red. Powder, bright yellow or orange. Taste, intensely bitter; not astringent.

Cinchona Rubra. *Red Bark.*

Obtained from unknown species. Occurs in quills or flat pieces. Quills from four to twenty inches in length, one-half to more than two inches in diameter. Flat pieces very large and thick. The

epidermis is strongly adherent; beneath it is a layer of dry-reddish resinous matter. Color, brownish or yellowish-red. Powder, brownish-red.

Composition.—The cinchona barks contain the alkaloids *cinchonia, cinchonidia, quinia, quinidia*, and *quinoidin*, in combination with *kinic acid*, besides cinchona red, cincho-tannic acid (green-black precipitate), and other substances. Cinchonidia is isomeric with cinchonia; quinidia with quinia. Quinoidin is amorphous quinia. The pale bark contains cinchonia principally, yellow bark quinia, and red bark quinia and cinchonia in equal quantities.

Therapeutics.—In small doses a tonic and nervine; in large doses an antiperiodic. As an "appetizer" it is inferior to the pure bitters, but it exerts an especial influence upon the nervous system, and is, therefore, useful in nervous exhaustion from any cause. Its influence upon the nerve centres is shown by the sense of fulness in the head, ringing in the ears, deafness, and even delirium, which it produces in large doses. Acts as a slight irritant to the alimentary mucous membrane, sometimes producing diarrhœa and nausea; and is therefore unsuitable where there is morbid irritability of that membrane. Used as a tonic in profuse suppuration, rheumatism, neuralgia, etc.; as an antiperiodic in malarial fever, intermittent neuralgia. As an antiperiodic, the alkaloids alone are used. As a tonic any of the following preparations may be employed:—

Infusum Cinchonæ. *Infusion* (℥j–Oj).

Infusum Cinchonæ Rubræ. *Infusion* (℥j–Oj).—Both infusions contain aromatic sulphuric acid (f℥j–Oj). Dose, f℥j–ij.

Decoctum Cinchonæ Flavæ (℥j–Oj).—*Decoction.*

Decoctum Cinchonæ Rubræ (℥j–Oj) *Decoction.*—Inelegant, turbid preparations. Dose, f℥j–ij.

Tinctura Cinchonæ.—Yellow cinchona (℥iij); diluted alcohol, Oj. Dose, fʒj–fʒij.

Tinctura Cinchonæ Composita. *Compound Tincture.* *Huxham's Tincture.*—Red cinchona, ℥iv; Bitter orange-peel, ℥iij; Serpentaria, ℥vj; Saffron, Red saunders, āā ʒij; Diluted alcohol, Oijss.

Extractum Cinchonæ. *Extract.*—An alcoholic, watery extract. Dose, gr. v–x.

Extractum Cinchonæ Fluidum. *Fluid Extract.*—Dose, fʒj.

Quiniæ Sulphas. *Sulphate of Quinine.*

Obtained by dissolving the alkaloids out of the bark by dilute muriatic acid, precipitating by lime (a salt of lime being left in solution), dissolving in boiling alcohol, evaporating, then adding dilute boiling sulphuric acid, allowing to cool and crystallize. Occurs in minute acicular crystals of intensely bitter taste, insoluble in pure water, soluble in acids. The solution in water acidulated with sulphuric acid is remarkable for an opalescent blue line on the surface. Chemically, a disulphate. *Test.*—Add tincture of iodine to a solution in acetic acid, and green scales, like the elytra or wing covers of the Spanish fly, are precipitated. They are the iodo-sulphate. If ammonia be added to a solution in chlorine water, an emerald-green color is produced.

Incompatibles.—Soluble salts of lead and baryta; alkalies and their carbonates; tannic acid. *Dose*, as a tonic, gr. j–iij; as an antiperiodic, gr. xij–ʒj, in divided doses between paroxysms.

Pillulæ Quiniæ Sulphatis.—Contain one grain each.

Quiniæ Valerianas. Valerianate of Quinine.—Occurs in small, colorless, rhomboidal crystals, of a bitter taste. Odor of valerianic acid. Used as a nervous tonic. Dose, gr. j–iij, with a solution of soda.

Cinchoniæ Sulphas. *Sulphate of Cinchonia.*

Obtained by precipitating the mother waters after the sulphate of quinia has crystallized out. Occurs in minute acicular crystals. Solubilities, incompatibles, and therapeutics those of quinine. Chemically a di- or subsulphate. If ammonia be added to a solution in chlorine water, a whitish color is produced. Dose, one-half more than of quinine.

The bark of the dogwood (Cornus Florida), of the tulip poplar (Liriodendron tulipifera), of the willow (Salix alba) are also tonic and feebly antiperiodic. They are at present seldom used. *Salicin* is the bitter, crystalline principle of willow bark.

STIMULATING TONICS.

Anthemis. *Chamomile.*

The flowers of the Anthemis nobilis, a native of Europe. Taste, bitter and aromatic. Odor, peculiar. Contain bitter extractive and a volatile oil. Yield to water and alcohol.

Therapeutics.—Tonic and stomachic. Used in enfeebled digestion.

Infusum Anthemidis. Infusion (℥ss–Oj boiling water).—Dose, f℥j–iij.

Serpentaria. *Serpentaria.* Virginia Snakeroot.

The root of our indigenous Aristolochia serpentaria. A knotted rhizome, with numerous, interlaced fine rootlets. Taste, peculiar, camphoraceous, bitter. Odor, aromatic, marked. Contains bitter extractive, resin, and volatile oil. Yields better to alcohol than water.

Therapeutics.—Stimulating and tonic, with some tendency to the skin and kidneys.

Infusum Serpentariæ. Infusion (℥ss–Oj).—Dose, f℥ss–ij.

Tinctura Serpentariæ. Tincture (℥ij–Oj).—Diluted alcohol.

Extractum Serpentariæ Fluidum. Fluid Extract.—An elegant preparation. Dose, fʒj.

Myrrha. *Myrrh.*

The concrete juice of the Balsamodendron myrrha, a native of Arabia. Occurs in tears and masses. Brownish-red color, more or less translucent; brittle, with a shining resinous fracture; and a bitter, aromatic, peculiar taste.

A gum-resin, containing a little volatile oil. Yields to alcohol; not to water.

Fig. 244.

Aristolochia Serpentaria.

Therapeutics. — Tonic and stimulating with a tendency towards the lungs and uterus. Locally stimulating, somewhat detergent. Used chiefly as an ingredient in stimulating emmenagogue mixtures, and in mouth-washes.

Tinctura Myrrhæ. Tincture. (℥iij – Oj).— Dose, f ʒj–ij.

AROMATICS.

Aurantii Amari Cortex.
Bitter Orange Peel.

The rind of the fruit of Citrus vulgaris. Taste, bitter and aromatic. Contains a bitter principle and volatile oil.

Therapeutics.—An aromatic tonic.

Aurantii Dulcis Cortex.
Sweet Orange Peel.

The rind of the fruit Citrus aurantium. Taste, aromatic. Contains a volatile oil.

Therapeutics.— Aromatic, not tonic; used only as a vehicle.

Confectio Aurantii Corticis. Confection.

Aurantii Flores. *Orange Flowers.*

The flowers of C. aurantium and C. vulgaris. Contain volatile oil. *Aqua Aurantii Florum.*—Orange-flower water. Used as a vehicle.

Cinnamomum. *Cinnamon.*

The bark of the Cinnamomum Zeylanicum of Ceylon, and the C. aromaticum of China. The Chinese variety is known as *Cassia bark*. It is inferior to the true cinnamon. The true cinnamon may be distinguished by its finer odor and taste, its thinness, and by its being in congeries of quills; one inside of the other. It commands a very high price, and is comparatively seldom met with in this country. Contains volatile oil and tannic acid.

Therapeutics.—Aromatic, and slightly astringent. Used principally for flavoring.

Oleum Cinnamomi. Oil.—Sp. gr. 1.035. Yellow, becoming red with age. By exposure to air absorbs oxygen and is converted into cinnamic acid, two distiet resins and water. Dose, gtt. j–v.

Aqua Cinnamomi.—(f℥ss–Oj.) Made by rubbing oil first with carbonate of magnesium. Dose, f℥ss–f℥j.

Tinctura Cinnamomi. Tincture.—(℥iij–Oij dilute alcohol.) Dose, f℥ss–ij.

Spiritus Cinnamomi. Spirit.—(Oil f℥j, strong alcohol f℥xv.) Dose, gtt. xx–xl.

Pulvis Aromaticus. Aromatic Powder.—Cinnamon, ginger, āā ℥ij; cardamom, nutmeg, āā ℥j. Dose, gr. xv–xxx.

Myristica. *Nutmeg.*

The kernel of the fruit of Myristica moschata, a native of the Molucca Islands. Contains volatile and fixed oil.

Therapeutics.—Aromatic, with some action on the nervous system. Dose, gr. xv–xxx.

Oleum Myristicæ. Volatile Oil.—Dose, gtt. iij–v.

Macis. *Mace.*

The arillus or membranous covering of the nutmeg, for which it may be substituted.

Caryophyllus. *Cloves.*

The unexpanded flowers of Caryophyllus aromaticus, which grows throughout the tropics. Contains volatile oil and resin. One of the most powerful of the aromatics. The oil (dose, gtt. j–ij) and infusion (dose, f℥j–ij) are officinal.

Pimenta. *Pimento. Allspice.*

Unripe berries of the Eugenia pimenta, a native of the West Indies. Contains a volatile oil, which is officinal. (Dose, gtt. ij–v.) A powerful aromatic.

Piper. *Black Pepper.*

The berries of the Piper nigrum, a native of the East Indies—when the berries are deprived of their outer coat they constitute *white pepper*. Contains a crystallizable substance, piperin, a greenish concrete oil or resin, and a volatile oil. Piperin has been supposed to be the active principle, but when pure is probably inert; it generally has with it more or less of the very acrid concrete oil. The volatile oil is limpid, with a strong odor, and a less acrid taste than the berries.

Therapeutics.—A powerful stimulant, local and general. It has some antiperiodic power. Used principally as a stimulant to the stomach; sometimes externally as a rubefacient.

Oleoresina Piperis. Oleoresin.—Dose, one or two minims. Used principally as an adjuvant to tonic and antiperiodic pills.

Cubeba. *Cubebs.*

The unripe berries of the Piper cubeba, a native of the East Indies. The berry is distinguished from black pepper by being furnished with a footstalk. The odor is aromatic; the taste, peculiar, disagreeable. Contains volatile oil and *cubebin*, the stearopterene of the oil. Yields to alcohol, not to water.

Therapeutics.—A stimulant, local and general, with a special tendency towards the kidneys. Used principally in the advanced stages of gonorrhœa in the male. Its active principle is eliminated by the kidneys, and acts locally on the mucous membrane of the urino-genital organs. Sometimes useful in chronic cystitis. Dose in powder, ℥ss–j.

Oleum Cubebæ. Oil.—Dose, gtt. xx.

Oleoresina Cubebæ. Oleoresin.—Best preparation. Dose, gtt. xv–xxv.

Tinctura Cubebæ. Tincture.—(℥ij–Oj dilute alcohol.) Dose, f℥ss–j.

Trochisci Cubebæ. Troches.—Used as local stimulants in relaxed fauces, etc.

Cardamomum. *Cardamom.*

The fruit of the Elettaria cardamomum, a native of the East Indies. Cardamom consists of an ovate or oblong capsule, inclosing numerous small, angular, irregular seeds, of a peculiar aromatic taste. Contains a volatile oil of a specific gr. .945; odor and taste those of the seeds.

Therapeutics.—A very agreeable aromatic, largely used as a flavoring adjuvant. Dose, gr. v–x.

Tinctura Cardamomi. Tincture.—(℥ij–Oj dilute alcohol.) Dose, f℥j–ij.

Tinctura Cardamomi Composita. Compound Tincture.—(Cardamom, ʒvj; caraway, ʒij; cinnamon, ʒv; cochineal, ʒj; honey, ℥ij; diluted alcohol, q. s. to make Oijss.) An elegant carminative. Dose, f℥j.

Zingiber. *Ginger.*

The rhizome of the Zingiberis officinale, a native of the East and West Indies. An irregular rootstock, with a brownish epidermis and fiery taste. When the epidermis is scraped off it is known as *white ginger*. This comes from Jamaica. Contains volatile oil, resin, starch, etc. Yields to boiling water, but better to alcohol.

Therapeutics.—A powerful aromatic stimulant. Much used as a stimulant to the alimentary canal.

Infusum Zingiberis. Infusion.—(℥ss–Oj boiling water.) Dose, f℥j–ij.

Tinctura Zingiberis. Tincture.—(℥iv–Oj.) Dose, fʒj–jss.

Syrupus Zingiberis. Syrup.—Used as a cordial drink in mineral waters, etc.

Oleoresina Zingiberis. Oleoresin.—Dose, gtt. j–ij.

Trochisci Zingiberis. Troches of Ginger.

The following aromatic seeds, the product of various umbelliferous plants, are officinal: *Fœniculum, Fennel* (plant *F. vulgare*);

Carum, *Caraway* (*Carum Carui*); *Coriandrum*, *Coriander* (*C. sativum*); *Anisum*, *Anise* (*Pimpinella anisum*). They all contain volatile oils, which may be used in doses of gtt. ij–vj.

The following labiates or plants of the Mint family are officinal. The herbal portions are employed; they all contain volatile oils; *Lavandula*, *Lavender* (*L. vera*); *Rosmarinus*, *Rosemary* (*R. officinalis*); *Mentha Piperita*, *Peppermint* (*M. piperita*); *Mentha Viridis*, *Spearmint* (*M. viridis*); *Melissa*, *Balm* (*M. officinalis*); *Hedeoma*, *Pennyroyal* (*H. pulegioides*).

The *spiritus lavandulæ compositus* contains: oil of lavender, f℥j; oil of rosemary, fʒij; cinnamon, ℥ij; cloves, ℥ss; nutmeg, a troyounce; red saunders, ʒvj; water, Oj; alcohol, Ovj. Dose, fʒij–iv. A very elegant local stimulant to the alimentary canal.

Gaultheria. *Wintergreen.*

The leaves of the G. procumbens contain a volatile oil much used for flavoring, which is also found in the bark of the sweet birch.

MINERAL TONICS.

Ferrum. *Iron.*

This is the most important of all the tonics, unless it be quinine. It is an integrant constituent of the red corpuscles, and appears to act as a powerful stimulus to the renovation of those bodies. Its preparations are, therefore, especially indicated, when from any cause they are deficient. In small continued doses it sharpens the appetite and promotes digestion, as well as acts directly on the blood-making organs. Metallic iron as well as many of its officinal preparations is insoluble in water; but they are all worked up into soluble compounds in the alimentary canal. The iron preparations are all more or less astringent, and for this reason it is frequently necessary to combine laxatives with them. The *chalybeates* are especially useful in *anæmia*, *chlorosis*, *chorea*, *hysteria*, *chronic intermittents*, various cachexiæ, and other affections in which the blood is impoverished. Plethora and sthenic inflammation contraindicate them.

Ferrum Redactum. Reduced Iron. Quevenne's Iron. Ferri pulvis. Iron by Hydrogen.—Metallic iron in the form of a very fine, gray, tasteless powder; obtained by passing a stream of hydrogen over the heated sesquioxide. Dose, gr. j–iij in pill.

Ferri Oxidum Hydratum. Hydrated Oxide of Iron.—Obtained by precipitating the solution of the tersulphate with ammonia, and washing. A reddish-brown powder, which must be kept under water. Used only as an antidote for arsenic. Must be in a moist state, freshly prepared and administered *ad libitum*. It may be extemporaneously made by precipitating with an alkali the tincture of the perchloride, and washing.

Ferri Subcarbonas. Subcarbonate of Iron.—A reddish insoluble brown powder, consisting of the sesquioxide with a little subcarbonate. Obtained by precipitating sulphate of iron with carbonate of sodium, and exposing the greenish precipitate to the air, from

which it absorbs oxygen. Especially recommended in neuralgia. Dose, gr. v–xx, in powder.

Pilula Ferri Carbonatis. Pills of Carbonate of Iron. Valleix's Mass.—A greenish-black mass of pilular consistency, consisting of the carbonate of iron, protected from oxygen by sugar. Obtained by mixing syrupy solutions of the protosulphate of iron and carbonate of sodium; reaction as above. An efficient chalybeate. Dose, gr. ij–v, t. d., in pill.

Pilulæ Ferri Compositæ. Compound Pills of Iron.—Made by mixing proto-sulphate of iron, carbonate of sodium, myrrh, and syrup; the salts of sodium and iron of course react as above. Used in amenorrhœa. Dose, gr. iv–viij.

Mistura Ferri Composita. Compound Mixture. Griffith's Antihectic Mixture.—Similar to last, except potash instead of soda, used in mixture. Dose, f℥ss.

Ferri Sulphas. Sulphate of Iron. Green Vitriol. Copperas.—Prepared by action of dilute sulphuric acid on iron wire. In bluish-green, efflorescent, soluble crystals; converted by heat into white powder (*ferri sulphas exsiccata*, U. S.); its water of crystallization being driven off.

Incompatibles.—Alkalies, alkaline earths and their carbonates, tannin, soluble salts of lime, baryta, lead, etc.

Therapeutics.—Locally, stimulant and astringent; internally, chalybeate and astringent. Used in chronic diarrhœa. Dose, in solution, gr. j–iv; of dried salt (heat), in pill, gr. ss–j.

Liquor Ferri Subsulphatis. Solution of the Subsulphate of Iron. Monsell's Salt. Persulphate of Iron.—Obtained by adding nitric acid and sulphuric acid (in small amount) to iron. A syrupy, ruby-red solution. The dried salt is deliquescent, reddish-brown, very soluble, and of a very astringent taste.

Therapeutics.—An exceedingly powerful, unirritating astringent. Used only as a styptic, and in hemorrhage from stomach or bowels.

Liquor Ferri Tersulphatis. Solution of the Tersulphate.—Made as last; but sulphuric acid added in sufficient quantities to neutralize the salt. A clear, reddish-brown solution of a very astringent acrid taste. A very irritating astringent, used only pharmaceutically in manufacture of the sesquioxide and its salts.

Ferri et Ammonii Sulphas. Sulphate of Iron and Ammonium. Ammonio-ferric Alum.—Obtained by adding sulphate of ammonium to solution of the tersulphate. In violet, efflorescent, soluble, octohedral crystals.

Therapeutics.—Astringent and chalybeate, with especial tendency to the uterine system. Used in atonic leucorrhœa, and in chronic diarrhœa.

Ferri Chloridum. Chloride of Iron.—Made by heating iron with nitric and muriatic acids. In orange, soluble, crystalline masses. Employed only as a styptic; perhaps inferior to Monsell's salt.

Tinctura Ferri Chloridi. Tincture of Chloride of Iron. Muriated Tincture of Iron.—Made by mixing nitric and muriatic acids with alcohol, water, and iron. A portion of the alcohol is converted into a peculiar ether. A clear orange-brownish solution, of a peculiar ethereal odor, very styptic ferruginous taste.

Incompatibles.—Alkalies, alkaline earths, and their carbonates, gum arabic, tannin.

Therapeutics.—Locally, a powerful astringent. Internally, chalybeate, astringent, and corrective in blood poisoning. Used in *erysipelas* (gtt. xx every two hours). Dose, as a chalybeate, gtt. xx–xxx t. d. It dissolves sulphate of quinia.

Syrupus Ferri Iodidi. Syrup of the Iodide of Iron.—Made by boiling iron and iodine in water, and adding syrup to protect from oxidation. A pale greenish syrupy liquid.

Therapeutics.—Used in *scrofula* and other cachexias when the joint action of iron and iodine is indicated. Dose, gtt. xx–xl, in water.

Ferri et Potassii Tartras. Tartrate of Iron and Potassium.—Made by adding the hydrated sesquioxide to the bitartrate of potassium. In soluble, ruby-red scales.

Therapeutics.—A simple chalybeate. Dose, gr. v–x.

Ferri et Ammonii Tartras. Tartrate of Iron and Ammonium.—Made by adding carbonate of ammonia and hydrated sesquioxide to tartaric acid. In garnety scales, very soluble; taste sweetish. A simple chalybeate. Dose, gr. v–x.

Ferri Citras. Citrate of Iron.—Obtained by evaporation of *liquor ferri citratis* (a solution of sesquioxide and citric acid in water). In garnety scales, soluble. A simple chalybeate. Dose, gr. v–x. The other officinal preparations of iron are, the *citrate of iron and quinine*, *citrate of iron and ammonium*, *lactate of iron* (greenish powder), *pyrophosphate of iron* (apple-green scales), all soluble, and the *phosphate of iron*, a slate-colored insoluble powder; all simple chalybeates; and *liquor ferri nitratis*, a powerful astringent, used in chronic diarrhœa.

Bismuthum. *Bismuthi.*

Bismuthi Subcarbonas. Subcarbonate of Bismuth.—Obtained by the double decomposition of nitrate of bismuth with carbonate of sodium. A whitish, insoluble, tasteless powder.

Therapeutics.—Same as subnitrate, except less tendency to cause constipation. Dose, gr. xv–xlv.

Bismuthi Subnitras. Subnitrate of Bismuth.—Made by dissolving bismuth in nitric acid, adding water largely. A compound is formed which when added to water breaks up into the insoluble sub- and a soluble pernitrate. A whitish, nearly insoluble, slightly sour powder, apt to be contaminated with arsenic.

Therapeutics.—Antispasmodic, absorbent, slightly sedative and astringent. Used in *pyrosis*, *gastralgia*, chronic diarrhœa, and dysentery. Dose, gr. v–xx, in powder or pill.

Argentum. *Silver.*

Argenti Nitras. Nitrate of Silver.—Made by adding silver to nitric acid. In colorless, soluble, rhomboidal plates. Taste intensely metallic, corrosive. Forms definite, solid compounds with albumen and fibrin. It turns tissues, first white, then black; melts at 426°, and forms *lunar caustic* (argenti nitras fusa), when run into moulds.

Therapeutics.—Locally a *superficial* caustic, or in solution stimulant and alterative. Its action as a caustic is prevented from going deeply into the tissue by the impenetrable coating formed. Internally, tonic and astringent, with special tendency towards the nervous system. Has been used in epilepsy, chronic dysentery, and chronic gastritis. Dose, gr. $\frac{1}{4}$–ss.

The *oxide* and *cyanide* of silver are both officinal; the former is used as an alterative and astringent in chronic disorders of the alimentary mucous membrane. Dose, gr. ss–j. The cyanide is used only in preparing hydrocyanic acid.

Test.—For soluble salts of silver, common salt.

MINERAL ACIDS.

Acidum Sulphuricum. *Sulphuric Acid. Oil of Vitriol.* Sp. gr. 1.845.

Therapeutics.—Locally, a powerful escharotic, destroying tissues by abstracting their water. Internally, tonic and astringent; very useful in colliquative sweats, serous diarrhœa, etc.

Acidum Sulphuricum Dilutum. Dilute.—(1 part in 8.) Dose, gtt. x–xx, in water.

Acidum Sulphuricum Aromaticum. Aromatic. Elixir of Vitriol.—(Sulphuric acid, ℥vj; Ginger, ℥j; Cinnamon, ℥iss; Alcohol, Oij.) Dose, gtt. x–xx.

Acidum Sulphurosum. *Sulphurous Acid.*

A nearly saturated watery solution of the acid gas, which is made by heating sulphuric acid with charcoal. Odor, that of burning sulphur.

Therapeutics.—Used as antifermentive and to destroy parasites.

Acidum Nitricum. *Nitric Acid.* Sp. gr. 1.42.

The nitroso-nitric acid of the shops is nitric acid containing nitrous acid, and is reddish.

Therapeutics.—Locally, a very powerful escharotic, or, largely diluted, a stimulant. Internally, astringent, tonic, and antiseptic; employed in low fevers. *Hope's Camphor Mixture.* Much used in serous diarrhœas; contains nitroso-nitric acid fʒjss, laudanum fʒj, camphor water f℥iv. Dose, a tablespoonful.

Acidum Nitricum Dilutum. Dilute.—(3 parts in 16.) Sp. gr. 1.068. Dose, gtt. xx–xl.

Acidum Muriaticum. *Muriatic Acid. Hydrochloric Acid.* (HCl.) Sp. gr. 1.16.

Odor, resembling that of chlorine, very corrosive.

Therapeutics.—Tonic and antiseptic, used in low fevers; in dyspepsia, with want of acid secretion. Dose, gtt. v–x, in water.

Acidum Muriaticum Dilutum. Dilute.—(1 part in 4.) Sp. gr. 1.03. Dose, gtt. x–xx, in water.

Acidum Nitromuriaticum. *Nitro-muriatic Acid.*

A mixture of 3 parts of nitric, with 5 parts of muriatic acid. Reaction unknown. Color golden-yellow. Odor resembling that of chlorine. Dissolves gold.

Therapeutics.—Tonic and alterative, with a special tendency to act on the liver. Useful in dyspepsia, with want of acid secretion; in chronic congestion and torpor of the liver; in *oxaluria* almost a specific. Often used externally in baths, in chronic affections of the liver.

Acidum Nitromuriaticum dilutum. Dilute.—(1 part in 4.) Dose, gtt. x–xxx.

Aqua Chlorini. *Chlorine Water.*

Solution of chlorine gas (2 volumes of gas, 1 of water). Greenish color; odor and taste of the gas.

Therapeutics.—Stimulant and antiseptic. Used internally in typhus and other blood affections. Locally, applied to gangrenous ulcers, putrid sore throat, etc. A powerful disinfectant.

Oleum Morrhuæ. *Cod-liver Oil.*

Fixed oil of the liver of the *Gadus morrhua*, or cod. Two varieties, a light yellowish, obtained from fresh livers by expression; a brownish dark oil, obtained from putrid livers by boiling in water. Contains biliary and fatty principles, *gaduin*, a trace of iodine and bromine. *Test*, a mineral acid with it causes a beautiful play of colors.

Therapeutics.—A laxative, alterative nutriment, useful in most chronic cachexias; especially in tuberculosis and scrofula. Dose, f℥ss t. d.

CHAPTER VI.

ARTERIAL OR DIFFUSIBLE STIMULANTS.

MEDICINES whose primary effect is to excite the heart's action and stimulate the circulation. Many nervous stimulants are also arterial stimulants, but those only are placed under this head whose influence on the arterial system is very marked.

They all act more or less powerfully as nervous stimulants. They are used to raise the system above some depressing influence, as in collapse, typhus fever, etc.; or to keep it up in extreme debility from any cause, until tonics and food can give the strength required. They differ from tonics in the fugitiveness of their action, but often serve the purpose of tonics by enabling the digestive system to act. They are contraindicated by sthenic inflammation and plethora. When in any febrile complaint they increase the rapidity of the pulse, the dryness of the skin and mouth, the tendency to delirium, they are doing harm, and must be suspended. When properly used in a low fever, they diminish all these.

Ammonii Carbonas. *Carbonate of Ammonium.*

Made by subliming chalk with chloride of ammonium. In fibrous, crystalline, translucent masses, which on exposure give off ammonia, and are converted into the opaque bicarbonate; taste,

sharp; odor, ammoniacal; reaction, alkaline; somewhat soluble in water; decomposed by alcohol.

Therapeutics.—A very powerful stimulant, characterized by rapidity and evanescence of its action. It has an especial tendency to act upon the lungs, and is used as a stimulant expectorant in typhoid pneumonia; also an antacid, etc. Dose, gr. v–x, given in emulsion.

Spiritus Ammoniæ Aromaticus. Aromatic Spirit of Ammonia.—A solution of ammonia and numerous aromatics in dilute alcohol. A pleasant cordial stimulant. Dose, f℥ss–j, in water.

Spiritus Ammoniæ. Spirits of Ammonia.—A solution of ammonia in dilute alcohol. Dose, f℥ss.

Ammonii Chloridum. *Chloride of Ammonium.*

Formerly known as *muriate of ammonia.* This salt is now obtained from the ammoniacal liquor of gas works; either by the addition of hydrochloric (muriatic) acid, and sublimation, or by the action, first, of sulphuric acid, making a sulphate of ammonium, which is decomposed by salt (chloride of sodium), the chloride of ammonium then being separated by sublimation.

It appears in tough, somewhat fibrous masses, colorless, inodorous, soluble in water and alcohol. Its solution, when heated with caustic potassa, yields ammonia. With nitrate of silver it gives a copious white precipitate of chloride of silver.

Therapeutics.—Less stimulating than the carbonate of ammonium, the chloride appears to stimulate the circulation gently, increasing the secretions. It is useful as a stimulating expectorant in *chronic bronchitis.* Sometimes recommended in *neuralgia.* Dose, gr. x–xx, in emulsion or mixture.

Oleum Terebinthinæ. *Oil of Turpentine.*

Obtained by distilling white turpentine, the resin being left behind. A volatile oil, colorless; odor, peculiar; taste, hot and peculiar. Sp. gr. 0.86. On exposure absorbs oxygen and is converted into resin.

Therapeutics.—Externally, a powerful rubefacient; internally, in small doses, a powerful stimulant, not only of the arterial and nervous systems, but of all of the secreting organs, especially the kidneys. In large doses, cathartic and anthelmintic. Used in low fevers, especially *typhoid*, when the tongue is dry and brown; in typhoid pneumonia, also in chronic inflammation of any mucous membrane (catarrh, dysentery, etc.). Dose, gtt. x–xxv, in emulsion. For tapeworm or roundworm, dose, f℥ss, with castor oil. Externally, whenever powerful counter-irritation over a large surface is desirable, flannels should be wrung out in it and applied.

Capsicum. *Cayenne Pepper.*

Fruit of the Capsicum annuum, a native of warm climates; conical, bright red pods; odor and taste, peculiar, fiery. Active principle, *capsicin*, a soft resinous substance. Yields to water and alcohol.

Therapeutics.—Locally, powerfully stimulant, rubefacient. In-

ternally, a general stimulant, used especially as a stimulant to the stomach. Dose, gr. v, in pill.

Infusum Capsici. Infusion. (℥ss–Oj).—Used chiefly as a gargle in sore throat of scarlatina, etc.

Tinctura Capsici (℥ss–Oj).—Dose, f℥j.

Oleoresina Capsici. Oleoresin.—Dose, gtt. j–iij, in pill.

Alcohol.

The hydrated oxide of ethyl. Obtained by submitting a solution of grape sugar to the *vinous fermentation*, by which the sugar is changed into it and carbonic acid, and separating it from the water by repeated distillation. The necessary conditions of this fermentation are a solution of grape sugar, some ferment or catalytic agent, and a temperature of from 60° to 90°. In the juices of various fruits are to be found the necessary elements. Hence when they are exposed to heat the process is set up. Thus, grape juice ferments into *wine*, apple juice into *cider*, infusions of barley into *malt liquors*, etc. All these liquors, the products of fermentation, are the so-called *fermented liquors.* The proportion of alcohol in them varies, but is never very great. Thus, in the strongest wines there may be 20 per cent. of alcohol; in the weakest, less than 10 per cent. Porter, ale, beer, and the various other malt liquors contain only from 3 to 8 per cent. When a fermented liquor is distilled, a product is obtained much stronger in alcohol, known as a *distilled liquor* or *ardent spirit;* such are brandy, rum, gin, etc. These contain from 45 to 55 per cent. of alcohol.

Alcohol has a very great affinity for water and is with difficulty entirely deprived of it. It is a transparent liquid, with a peculiar hot taste. It boils at 172°, and has not yet been frozen. It is a powerful solvent and at the same time preservative, and is therefore much used in pharmacy. It coagulates albuminous principles. Absolute alcohol has a sp. gr. of 0.7938, but is never used in the arts. There are three strengths of alcohol which are officinal. *Alcohol fortius*, sp. gr. 0.817. *Alcohol*, sp. gr. 0.835, contains 15 per cent. of water. *Alcohol dilutum*, sp. gr. 0.941, consists of equal measures of water and alcohol mixed.

Therapeutics.—Alcohol is by far the most potent stimulant in our possession. It acts not only upon the vascular, but also even more powerfully on the nervous system, and has the power in overdose of producing coma ending in death. It is our chief dependence whenever stimulation is indicated, as in low fevers. It has also a strong tendency to increase the action of the skin. It is a local stimulant to the stomach, and is often useful in *dyspepsia.* It is never administered in the form of alcohol, but is given in some of the liquors or wines. As a tonic, the *malt liquors* are generally preferable. As stimulants, wine, or when stronger stimulation is desirable, brandy or whiskey must be employed. *Wine whey* is made by adding half a pint or less of sherry wine to a pint of boiling milk, and straining. The following are the officinal liquors: *Spiritus Frumenti, Whiskey. Spiritus Vini Gallici, Brandy. Vinum Xericum, Sherry Wine. Vinum Portense, Port Wine.* The last contains tannic acid, and is therefore especially useful when there is a tendency to diarrhœa. The prolonged,

habitual use of any distilled liquor is very apt to give rise to a dangerous train of nervous symptoms, and also to chronic disease of the liver.

Phosphorus. *Phosphorus.*

This substance was formerly much used as a stimulant and aphrodisiac in doses of one-twelfth of a grain or less, but is at present rarely employed. *Acidum Phosphoricum Glaciale.* A white, transparent solid, inodorous, of a sour taste. Used in the manufacture of dilute phosphoric acid. *Acidum Phosphoricum Dilutum.* Made by heating phosphorus with nitric acid in water. A colorless, very acid, non-corrosive liquid.

Therapeutics.—It has been used as a tonic and refrigerant, especially in sexual atony, and to prevent urinary phosphatic deposits; also in cases of brain-exhaustion. Phosphorus is safe in doses of $\frac{1}{30}$ of a grain, twice daily; preferably, dissolved in oil. *Phosphide of zinc* has lately been introduced for similar uses; its dose, also, is very small, and its administration requires caution.

CHAPTER VII.

NERVOUS STIMULANTS OR ANTI-SPASMODICS.

These are medicines whose most decided impression is made upon the nervous system, especially the motor nervous system. They are used principally to allay spasm, connected with a weakened rather than an inflammatory condition of the nerve centres, as in hysteria, hooping-cough, etc. Sthenic arterial excitement, or inflammation of the nervous centres, contraindicates their use.

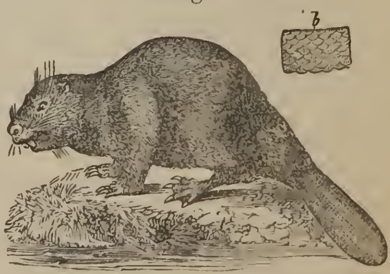
Moschus. *Musk.*

A peculiar substance obtained from a sac, situate between the umbilicus and prepuce of the Moschus moschiferus or Musk deer

Fig. 245.

Moschus Moschiferus.

Fig. 246.



Castor Fiber.

of Tartary. Musk sac oval, two to three inches long, one side bare, the other with coarse hairs arranged concentrically around the small opening. It contains an unctuous granular powder.

Therapeutics.—A powerful nervous stimulant, useful in hiccough, hysterical convulsions, etc. In large doses it produces vertigo and other symptoms of cerebral disturbance. At present but little used, on account of its price and common adulteration. Dose, gr. j–v, in pill or emulsion.

Castor. *Castor.*

A peculiar substance obtained from a sac situated between the anus and external genitals of the beaver (Castor fiber). Sacs in pairs, one abortive, the other pyriform, one and two-third inch long, wrinkled, brownish, divided internally into cells containing the castor. An unctuous substance, of peculiar odor, brittle, with a somewhat resinoid fracture.

Therapeutics.—Similar to but less powerful than musk. Dose, gr. x–xx, in pill or emulsion.

Tinctura Castorei. Tincture (℥j–Oj).—Dose, f℥j.

Assafœtida. *Assafetida.*

The product of Narthex assafœtida, an umbelliferous plant of Persia, obtained by slicing off the top of the root, and collecting the juice as it exudes. Ordinarily in masses, softish at first, but becoming hard and reddish on exposure; sometimes in tears, which are white; resinoid fracture, taste bitter, acrid, peculiar; odor peculiar, garlicky. A gum-resin, containing some volatile oil.

Therapeutics.—Powerfully antispasmodic; also a stimulant of almost all the secretions, laxative, often a useful carminative, especially in nervous flatulence. Used in hysteria, hooping-cough, functional convulsions, etc. Dose, gr. v–x, in pill.

Mistura Assafœtidæ. Assafetida Mixture. (℥ss–Oj.)—An emulsion, made by rubbing with water, the gum holding the resin suspended. Dose, f℥ss–j. Often administered as an enema.

Tinctura Assafœtidæ. Tincture. (℥ij–Oj.)—Dose, gtt. xx–f℥j.

Emplastrum Assafœtidæ. Plaster.—May be applied to the spine in infantile convulsions, to the chest in chronic bronchitis, etc.

Valeriana. *Valerian.*

The root of the Valeriana officinalis, a native of Europe, consists of numerous long, slender rootlets arising from a tuberculated head. Odor, strong, peculiar; taste, bitter and aromatic, at first sweetish. Contains *volatile oil*, in which exists the *valerianic acid*, a colorless, sour liquid, with odor resembling that of valerian; it appears to be the result of oxidation of the oil.

Therapeutics.—A very valuable nervous stimulant, especially useful in the "nervousness" of females. Dose, gr. xx–ʒss, seldom given in substance.

Infusum Valerianæ. Infusion.—Dose, f℥ss–ij.

Tinctura Valerianæ. Tincture.—Dose, f℥j.

Tinctura Valerianæ Ammoniata. Ammoniated Tincture.—Stimulating and antacid, especially useful in hysterical cases.

Extractum Valerianæ. Extract.—Very little used. Dose, gr. iij–vj, in pill.

Extractum Valerianæ Fluidum. Fluid Extract.—An excellent preparation. Dose, f℥ss–f℥j.

Ammonii Valerianas. Valerianate of Ammonium.—Occurs in small, four-sided, pearly, tabular crystals, with the odor of valerianic acid. When properly prepared, not deliquescent.

Zinci Valerianas.—Valerianate of zinc. A nervine tonic. Dose, 1 grain twice daily.

Therapeutics.—A useful stimulant, antispasmodic. Used in nervous headache. Dose, gr. v–xv, in solution.

Oleum Succini. *Oil of Amber.*

A thick, dark, empyreumatic oil, obtained by the destructive distillation of amber, a fossil resin, the product of some extinct coniferous trees. Odor, very strong, disagreeable. Never used in this form.

Oleum Succini Rectificatum. Rectified Oil of Amber.—Obtained by re-distillation of the oil with water. Color, pale amber, strong peculiar odor and taste.

Therapeutics.—A powerful nervous and arterial stimulant, also a stimulant of the secretions, especially the urinary; and externally, a rubefacient. Used in obstinate hiccough, nervous cough, hysteria, hooping-cough, and infantile convulsions. In the last two disorders frictions with it along the spine are often advantageous. Dose, gtt. v–x, in emulsion.

CHAPTER VIII.

CEREBRAL STIMULANTS.

MEDICINES whose most obvious influence is upon the cerebrum. With several of them, at least, this influence may be considered to be primarily stimulant. It is usual to describe three stages of their action. 1st. That of stimulation, in which the functions of the brain are more readily performed; 2d. That of narcotism or sleep, in which the sensibility is impaired, and consciousness lost in more or less profound sleep; 3d. That of depression and weakness.

There are no medicines over whose powers habit has so much control, nor are there any against which special disease so fortifies the system. Thus, the opium debauchee gradually travels from his twenty or thirty drops of laudanum a day to his wineglassful; and every one is familiar with the large doses of opium required to affect a man amid the phantasies of delirium tremens. They are chiefly employed as *anodynes* to allay pain; as soporifics to produce sleep; sometimes as stimulants, sometimes as antispas-

modics. Classed under this head, also, are a number of drugs, which are very closely allied in their properties (the mydriatics), and are distinguished by their expanding the pupil of the eye; these are hyoscyamus, stramonium, and belladonna, prussic acid, and perhaps cannabis indica.

Opium. *Opium.*

The concrete juice of the Papaver somniferum, or poppy. It is obtained by making superficial vertical incisions, and collecting the juice the next day after it has exuded. The ripe capsules are themselves sometimes used in medicine; they are oval, yellowish-brown, half to two inches in diameter, crowned by the remains of the stigma and filled with minute seeds. They are slightly narcotic. The seeds yield plentifully a bland fixed oil (poppy oil), and are not at all narcotic. The three principal varieties of opium occurring in commerce are the Indian, Egyptian, and Turkey opium. Of these the first two are not seen in our market. The Indian is said to occur in round masses covered with the petals of the poppy; it is chiefly consumed by the opium-eaters of China.

Fig. 247.

PAPAVER SOMNIFERUM.—1. Capsule of *P. officinale.* 2. Capsule of *P. somniferum.* 3, 4. Seeds.

Egyptian Opium is in flat cakes about three inches in diameter or larger, covered with a poppy leaf. It is a very inferior variety. Of *Turkey Opium* there are two distinct varieties, the *Smyrna* and *Constantinople.*

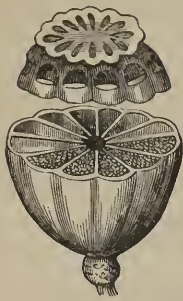
Smyrna opium is the variety commonly met with in the American market. It occurs in roundish masses of various sizes, originally globular, but irregular from mutual pressure, and covered with the seeds of a species of *rumex* (dock), the whole often enveloped in poppy leaves. The color is brownish-red, in the interior softish, and exhibits traces of tears; on exposure it becomes darker and harder.

Constantinople, rarely seen here, simulates very closely the Smyrna, but has no tears.

The marks of good opium are, its peculiar odor and bitter acrid taste being well marked, and its leaving an interrupted line when drawn across writing paper.

Chemical Composition.—The principal ingredients are the alkaloids *morphia* and *codeia*, which exist in combination with meconic

Fig. 248.



Capsule of the Opium Poppy.

acid; besides these there are *narcotina* (nearly neutral), odorous principle, resin, paramorphia, etc.

Tests.—Opium strikes a red color with solution of a persalt of iron (meconate of iron being formed). *Morphia* is reddened by nitric acid; strikes a deep blue with a persalt of iron.

Physiological Effects.—The first effect of opium when taken internally is a stimulant one, which is chiefly felt in the cerebral nervous system. The circulatory system also manifests the effect of the stimulation, although not to a very marked degree; there is some increase in the force and frequency of the pulse, and in the heat of the skin. This stage is shorter or longer in inverse proportion to the size of the dose. It is followed by diminished sensibility, calmness, sleep, and diminution of all the secretions except that of the skin, the symptoms of the second stage. When the dose is very large, the first stage may be so transient as not to be noticed, and the symptoms of the second may be those of profound narcotism. There is more or less complete unconsciousness, with slow, stertorous breathing, very contracted pupils, a very slow, full pulse, and more or less lividity of the countenance. Of course between this profound narcotism and the second stage as first noticed, there is every gradation. The third stage is that of prostration, and its severity is in direct proportion to that of the second. Sometimes, however, it almost replaces the second stage. The symptoms are a feeble, frequent pulse, general relaxation, dilated pupils, unconsciousness, etc. In opium poisoning, the first indication is to evacuate the stomach. This may be done by the stimulating emetics, such as mustard, sulphate of zinc and copper, etc.—or by the stomach pump when a *liquid* preparation has been used—after this, the tendency to sleep must be counteracted by mechanical means, such as teasing the patient, walking him about, slapping him, dashing cold water over him, etc.; and the *physiological antidotes* should be exhibited, and the system be supported if symptoms of prostration come on. The antidotes are tincture of belladonna, tincture of hyoscyamus, and very strong coffee.

Uses.—Opium is used as an *anodyne* to relieve pain, and to allay nervous irritation in an infinite variety of cases; as a *hypnotic*, to produce sleep, except when there is inflammation or inflammatory irritation of the brain; as a *stimulant* in low fevers; as *an arrester of secretion* in diarrhœa; as a *diaphoretic* in various conditions. In some cases it produces obstinate wakefulness and various unpleasant symptoms, preventing its use. Dose, gr. j–ij.

Tinctura Opii Camphorata. Paregoric (gr. ij–f℥j).—Contains camphor, benzoic acid, oil of anise, etc. Much used in diarrhœa and cough mixtures. Dose, fʒij–vj.

Tinctura Opii. Laudanum (gr. 37½–f℥j).—When long kept it must be used with caution, as its strength may be very much increased by the evaporation of the alcohol; contains 120 drops to the drachm. Dose, gtt. xxv.

Tinctura Opii Deodorata. Deodorated Tincture (gr. 37–f℥j).—Really, a watery preparation, with a little alcohol to preserve it. Contains no *narcotina*, and is therefore considered to produce less unpleasant effects than the other preparatious. Dose, gtt. xxv.

Tinctura Opii Acetata. Acetated Tincture (gr. 48–f℥j).—Contains alcohol and acetic acid. Dose, gtt. x–xv.

Acetum Opii. Vinegar. Black Drop (gr. 75–f℥j).—Dose, gtt. v–x.

Vinum Opii. Wine (gr. 60–f℥j).—Dose, gtt. viij–xij.

Confectio Opii. Confection (gr. 1 in 35).—Dose, ʒss.

Pilulæ Opii. Pills, 1 grain each.

Pilulæ Saponis Compositæ. Compound Pills of Soap (opium, gr. lx, with soap, ℥ss).—Dose, gr. v.

Pulvis Ipecacuanhæ Compositus. Compound Powder of Ipecacuanha. Dover's Powder.—Made by rubbing opium, ipecac, and sulphate of potassium together in the proportion of one of each of the former to eight of the latter. The sulphate of potassium probably has no effect on the system, but owing to its great hardness and splintery fracture in pulverizing it reduces the opium and ipecac to a very fine powder. Used as a powerful diaphoretic. Dose, gr. x.

Morphia.

Obtained by precipitating a watery infusion of opium with a mixture of alcohol and water of ammonia. The meconates are decomposed by the alkali, the codeia dissolves in the alcohol, the morphia falls. The crystals are purified by solution in boiling alcohol, passing through animal charcoal, and recrystallization. Colorless acicular crystals, almost insoluble in cold but slightly soluble in hot water, freely so in boiling alcohol.

Morphiæ Sulphas. Sulphate of Morphia.—Obtained by dissolving morphia in very dilute sulphuric acid—in acicular crystals, bitter taste, very soluble in water. Dose, gr. ¼.

Liquor Morphiæ Sulphatis. Solution (gr. j–f℥j).—Dose, fʒij.

Magendie's Solution of the sulphate of morphia has a strength of sixteen grains to the ounce. The muriate and acetate of morphia are also officinal. Their medical properties and dose are those of the sulphate. When opium is to be used endermically or hypodermically some salt of morphia must be employed.

Lactucarium.

The inspissated juice of the Lactuca sativa, or garden lettuce; a brownish solid, with a somewhat resinoid fracture. It has been thought to resemble opium in its action on the economy, except in its not producing constipation. Its action is, however, very uncertain. Dose, gr. x–xv.

Syrupus Lactucarii. Syrup (℥j–Oj).—Sometimes used as an anodyne vehicle in cough mixtures. Dose, fʒij–f℥ss.

Hyoscyami Folia. *Henbane Leaves.* **Hyoscyami Semen.** *Henbane Seed.*

The product of Hyoscyamus niger, a biennial plant of Europe. The leaves of the second year should alone be used, gathered directly after flowering. When dry they should retain some of the tobacco-like odor of the plant, and have a bitter narcotic taste. The seeds are small, compressed, roundish, grayish, of a bitter, somewhat oily taste. Both contain the alkaloid *Hyoscyamia*, which may be obtained in transparent needle-like crystals, of bitter disagreeable taste, slightly soluble in water, freely in alcohol.

Fig. 249.

Hyoscyamus Niger.

Therapeutics.—Given in moderate doses it gently stimulates the circulatory system, and exerts a marked influence on the cerebrum; quiets nervous irritation, and produces a tendency to sleep. Unlike opium, it does not check but rather aids secretion, often acting as a laxative. In overdoses it causes delirious intoxication, great dryness of the mouth and throat, disordered vision, widely dilated pupils, irritation of the alimentary canal, with diarrhœa, followed by nervous jactitations or even convulsions, paralysis, and death. If the patient recover, he is totally unmindful of the scenes in which he has been an active performer. Coma may be said to mark opium poisoning, delirium that of hyoscyamus. Used in neuralgia, etc., as an anodyne.

Extractum Hyoscyami. Extract.—The inspissated juice of the leaves. Dose, gr. ss–ij, in pill.

Extractum Hyoscyami Alcoholicum. Alcoholic Extract.—Made from the leaves. Dose, gr. j–ij.

Extractum Hyoscyami Fluidum. Fluid Extract.—Made by evaporating a tincture of the leaves. Dose, gtt. v-x.

Tinctura Hyoscyami. Tincture. (Leaves ℥ij–Oj.)—Dose, gtt. xx–f℥j.

Belladonnæ Radix. *Belladonna Root.* **Belladonnæ Folium.** *Belladonna Leaf.*

The product of Atropa belladonna, an herbaceous perennial of Europe. The leaves are ovate, pointed, entire, on footstalks. When dry, nearly odorless; taste feeble, somewhat acrid. Both contain *atropia*.

Therapeutics.—Almost precisely the action of hyoscyamus, but more energetic. It is much more used as a local application to the eye to produce dilatation before the cataract operation, ophthalmoscopic examinations, etc., or to prevent adhesions in iritis.

Fig. 250.

ATROPA BELLADONNA.

The preparations, except atropia, are all made from the leaves.

Extractum Belladonnæ. Extract.—Inspissated juice. Dark greenish color, narcotic odor. Dose, gr. $\frac{1}{4}$–j, in pill.

Extractum Belladonnæ Alcoholicum. Alcoholic Extract.—Dose, gr. $\frac{1}{4}$–j.

Tinctura Belladonnæ. Tincture (℥ij–Oj).—Dose, x–xx.

Unguentum Belladonnæ. Ointment.

Emplastrum Belladonnæ. Belladonna Plaster.—An anodyne plaster, often used in nervous irritability of the heart, etc.

Atropia.—Obtained from the root; yellowish-white, silky, prismatic crystals, inodorous, bitter acrid taste, slightly soluble in water, soluble in alcohol.

Atropiæ Sulphas. Sulphate of Atropia.—A white, slightly crystalline powder, with taste of atropia, very soluble in water and alcohol. Atropia and its sulphate have the same action on the system as belladonna; they are terribly energetic, and should not be used in larger quantities than $\frac{1}{30}$ of a grain. They are rarely used internally. A drop of a solution of the sulphate (gr. ij–f℥j) is often put into the eye by the surgeon to dilate the pupil.

Stramonii Semen. *Stramonium Seeds.* **Stramonii Folium.** *Stramonium Leaves.*

The product of the Datura stramonium, or Jamestown weed, an annual which flourishes throughout the civilized world, growing in waste places. Contains an alkaloid, *Daturia*, which very closely resembles atropia.

Therapeutics.—Its effects on the system very closely resemble those of hyoscyamus, but it appears to have a greater power of relaxing spasm; hence it is used especially in spasmodic asthma, very frequently by smoking. Some caution is necessary to avoid poisonous effects.

Fig. 251.

DATURA STRAMONIUM.

Extractum Stramonii. Extract.—Inspissated juice of leaves. Dose, gr. j–ij.

Extractum Stramonii Foliorum. Extract of Stramonium Leaves. Dose, gr. $\frac{1}{4}$–j.

Tinctura Stramonii. Tincture. (Seeds ℥ij–Oj.)—Dose gtt. x–xx.

Unguentum Stramonii. Ointment. (Extract ʒj, water fʒj, lard ℥j.)—Used as an anodyne application to painful piles, etc.

Dulcamara. *Bittersweet.*

The stalks of Solanum dulcamara, a native of Europe, naturalized in this country. Occurs in small pieces about one-fourth of an inch in diameter, grayish color, without odor; taste at first bitter, afterwards sweetish; contains an alkaloid, *solania.*

Fig. 252.

SOLANUM DULCAMARA.

Therapeutics.—Very feebly narcotic, never used as such. It appears to increase the secretions generally, and to have a special direction to the skin; employed chiefly as an alterative in chronic skin diseases, particularly the scaly ones.

Decoctum Dulcamaræ. Decoction. (℥j–Oj.)—Dose, f℥ij, t. d.

Extractum Dulcamaræ. Extract.—Alcoholic. Dose, gr. v–x, t. d.

Extractum Dulcamaræ Fluidum. Fluid Extract.—Dose, f℥ss–f℥j.

Humulus. *Hops.*

The strobiles or fruit of the Humulus lupulus, or Hop vine, which grows in Europe and North America. Consists of a number of greenish scales, arranged in an imbricated manner around a common axis, so as to form an oval head or cone. Taste bitter, aromatic; odor peculiar. At the bases of the scales are little glands containing a yellowish powder, Lupulin (LUPULINA, U. S.), which contains most of the active principle, a resinoid substance, *lupulin* or *humulin.*

Therapeutics.—Stomachic, tonic, and somewhat narcotic. Used as a hypnotic in morbid wakefulness, dependent upon nervous debility, as in drunkards; sometimes used in form of *pillow*, stuffed with moistened hops. Hop poultices make a very nice anodyne application.

Infusum Humuli. Infusion. (℥ss, boiling water Oj.)—Dose, f℥j–iij.

Tinctura Humuli. Tincture. (℥ijss–Oj.)—Dose, f℥j–f℥ss.

Lupulina.—May be given in pill. Dose, gr. vj–xij.

Tinctura Lupulinæ. Tincture. (℥ij–Oj.)—Dose, f℥ss–f℥ij.

Extractum Lupulinæ Fluidum. Fluid Extract.—Dose, f℥ss–j.

Oleoresina Lupulinæ. Oleoresin.—Dose, gr. iij–℥ss, in pill or solution.

Extractum Cannabis. *Extract of Hemp.*

An alcoholic extract of Cannabis sativa, or common hemp, of the variety which grows in India. The hemp plant has been long used in the East for producing a species of intoxication. The dried tops, cut after flowering, are known in India as *gunjah*, in Arabia as *hashish;* the resinous matter which exists on the surface of the plant is *churrus.* The officinal extract is an alcoholic one. It contains largely of *cannabin*, the resinous active principle, soluble in 95 per cent. alcohol and ether, insoluble in water.

Therapeutics.—A powerful narcotic, producing exhilaration, delirium, drowsiness, sleep, stupor. In large doses, it generally causes visions, and often marked anæsthesia of the limbs, sometimes catalepsy. Its action is very uncertain. Dose, gr. ⅛–gr. ss.

Extractum Cannabis Indicæ. Extract.—Dose, gr. ⅛–gr. j.

Tinctura Cannabis. (℥ij–Oj).—Dose, gtt. v–x.

Extractum Cannabis Americanæ is now also officinal. It possesses the same power as the Indian hemp, in nearly the same degree.

Camphora. *Camphor.*

Product of Camphora officinarum, an evergreen tree of China and Japan. It exists in all parts of the tree, and is obtained by heating chips of the wood, especially of the root and branches, and condensing into various receptacles the *crude camphor* of commerce. After purification by resublimation with quicklime, it is *refined camphor.* Occurs in crystalline, colorless, translucent masses, readily breaking into coarse granules, but very difficult to pulverize; very volatile, lighter than water, very inflammable; scarcely at all soluble in water, freely in alcohol, still more so in chloroform. Odor strong, peculiar; taste bitter, pungent, with an after feeling of coolness. Chemically it is closely allied to the volatile oils, and is thought to be an oxide of the radical *camphene.* The *oil of camphor* is sometimes used.

Therapeutics.—A stimulant, in moderate doses producing calmness, increased action of the arterial system and skin, etc. In overdose causing vertigo, drowsiness, and even convulsions, coma, prostration, death. It is also a powerful stimulant to the mucous membrane of the alimentary canal. Used in "nervousness," dependent on weakness, in typhoid cases, in asthenic diarrhœas and dysenteries.. Dose, gr. v–x, in emulsion.

Aqua Camphoræ. Camphor Water. (ʒj–Oj.)—Dose, f ℥ss–j.

Spiritus Camphoræ. Spirit. (℥ij–Oj.)—Dose, gtt. xx–xxv.

Linamentum Camphoræ. Liniment. (℥j–olive oil ℥iij.)—Also an ingredient of soap liniment.

Conium. *Conium.*

The leaves of Conium maculatum, commonly called *hemlock*, a biennial umbelliferous plant of Europe, naturalized in the United States. It is believed to be the plant which yielded the state poison of the Greeks, by which Socrates died. The plants which grow in bright, sunny positions are said to be far the most active. The leaves should be green, and exhale strongly their peculiar odor on the addition of a few drops of liquor potassæ. Active principle is a volatile alkaloid, *conia*, which exists in combination with *coniic* acid, a yellowish, oily, very acrid liquid, three drops of which suffice to kill a large cat in a minute and a half; it has a peculiar odor, thought by some to resemble that of mice.

Therapeutics.—More properly a nervous sedative than narcotic; sedative to the circulation. There appears to be scarcely a stage of stimulation, but a sedation of the motor nervous system, with nausea, vertigo, debility, etc.; over-doses cause vertigo, dilated pupil, delirium, or stupor, difficulty of speech, tremor and paralysis, followed by convulsions and death. In small, continued doses it has been recommended as a deobstruent in goitre, cancerous and other tumors. Dose, gr. ij–v.

Extractum Conii. Extract.—Inspissated juice. Dose, gr. j–ij.

Succus Conii.—A very strong preparation of the fresh juice, with one-fifth part by measure of alcohol. Dose, gtt. j–iij.

Extractum Conii Alcoholicum. Alcoholic Extract.—Dose, gr. ss–j.

Extractum Conii Fluidum. Fluid Extract.—Dose, gtt. iij–vj.

Tinctura Conii. Tinctura. (f ℥ij–Oj.)—Dose, gtt. xx–xxx.

Fig. 253.

CONIUM MACULATUM.

Æther. *Ether.*

The oxide of ethyl. Obtained by distilling alcohol and sulphuric acid, which takes away the water from the hydrated oxide of ethyl (alcohol), and the ether passes over—contaminated with sulphurous acid, oil of wine, etc. These are removed by washing with water containing potassa, and redistillation. *Æther Fortior*, U. S., is obtained by removing the water from the product by quicklime and the chloride of calcium. A very inflammable, volatile liquid. Sp. gr. 0.750, soluble in five parts of water, freely soluble in alcohol.

Therapeutics.—Its effects on the system resemble those of alcohol, but are much more rapid and transient. They are, increased arterial action with delirium and diminished sensibility, followed by unconsciousness, relaxed muscles, contracted pupil, full, strong pulse, and then the stage of exhaustion. Used chiefly as an anæsthetic and relaxant in surgery. Internally used, as a powerful diffusible stimulant in sudden prostration; as an anodyne stimulant in colic. Dose, f℥ss–j, given with *cold* water. Externally, when allowed to evaporate, produces cold, when confined to the skin a rubefacient and anodyne effect.

Spiritus Ætheris Compositus. *Compound Spirit of Ether. Hoffman's Anodyne.*

Ether, Oss; Alcohol, Oj; heavy oil of wine, f℥vj. A transparent fluid, with odor resembling that of ether, peculiar taste, becoming milky when added to water. *Heavy Oil of Wine* (sulphate of ether and etherole) is a yellowish, heavy liquid of peculiar odor and taste; soluble in alcohol, insoluble in water.

Therapeutics.—A mild anodyne and good nervous stimulant. Used as a hypnotic in nervous sleeplessness. Also carminative.

Chloroformum. *Chloroform.*

The chloride of the radical formyl, the result of distilling chlorinated lime, alcohol, and water together. A non-inflammable, very volatile liquid, with a peculiar pleasant odor, and sweet aromatic taste. Soluble in alcohol and ether, insoluble in water. Sp. gr. 149, boiling point 142°. A fluidrachm of it contains from 250 to 300 drops. Before use, commercial chloroform requires to be purified; it is then *chloroformum purificatum* U. S. When dropped into water it should sink in globules without milkiness.

Therapeutics.—A *direct sedative* to the nervous system, used as an anæsthetic by inhalation; but it frequently causes death by paralysis of the heart. Much employed as a local anodyne in neuralgic pains, etc. Internally, by the mouth, very useful in cramps of the bowels, colic, gastralgia, gout in the stomach; and in small doses as an anti-emetic. Also given as soporific and general anodyne. In large doses (f℥j), sometimes used as an antiperiodic. Dose by the mouth, gtt. v–f℥ss.

Linimentum Chloroformi. Liniment (℥iij, olive oil ℥iv.)—Anodyne. Used in chronic rheumatism, neuralgia, etc.

Iodoformum (Iodoform) is now officinal. It occurs in yellow, scaly crystals, with a saffron-like odor. It is not soluble in water, but is soluble in alcohol, ether, and oils. It is volatile at ordinary temperatures, and is decomposed at 250° F., giving off a violet-colored vapor. Its therapeutic properties are not as yet very well known. It has been given especially in syphilis, rheumatism, and chronic ague. Externally it is applied to syphilitic sores, in powder, or with glycerin.

Chloral. *Hydrate of Chloral.*

Pure chloral is made by the direct action of chlorine gas upon absolute alcohol. By mixing it with water *hydrous chloral*, usually called hydrate of chloral (or chloral hydrate), is formed. This is a solid, white, crystallizable mass, which fuses and evaporates without combustion; boiling at 293° F. It is soluble in water, alcohol, ether, and oils. Its aqueous solution, when pure, is neutral to test-paper, and gives no reaction with nitrate of silver, and no red fumes when heated with nitric acid.

Therapeutics.—Liebreich, who introduced chloral into use as a medicine, proposed the view that it is decomposed in the blood, yielding chloroform, and producing its hypnotic effect. Experience shows it to be an extremely valuable agent, especially for the pro-

motion of sleep; as an anodyne, it is much inferior to opium. Generally, its after-effects are less marked and disagreeable than those of opiates. It is considerably used in delirium tremens and tetanus. Being pungent and disagreeable, it is often given in the form of a syrup. Dose, 15 to 30 grains. The smallest poisonous dose has not yet been certainly determined; but it is not safe to increase the amount given, more rapidly than would be done with opiates, under like circumstances.

CHAPTER IX.

EXCITO-MOTOR STIMULANTS.

MEDICINES which stimulate the anterior motor columns of the spinal centres, so that they call into action the muscular tissue through the agency of the spinal nerves. They are used either in one or two large doses to excite muscular contraction, or in small, repeated doses as stimulants to debilitated nerve centres.

Nux Vomica.

The seeds of the Strychnos nux vomica, an East Indian tree. The fruit is juicy, about the size of an orange, and contains numerous seeds. These are circular, somewhat concavo-convex disks, about three-quarters of an inch in diameter, covered with a dense silky down, and internally very hard and tough, slightly translucent, hornlike. They are odorless, but have an intensely bitter taste. Yield to alcohol. Contain the alkaloids *strychnia* and *brucia* in combination with *igasuric acid.* Brucia is rendered intensely red by nitric acid.

Therapeutics.—When given in very small doses nux vomica acts as a tonic, increasing the appetite and especially reinvigorating weakened motor nerves. It is therefore used often as a simple tonic, and especially where there is any want of motor power without inflammation or acute irritation of the nerve centres. Thus it is employed in paralysis, even after apoplexy, provided all symptoms of brain irritation have passed away; and with far greater success in functional paralysis, such as follows diphtheria; in weakening of the muscular coat of the bowels and bladder, and of the sphincters. Very often the first symptom of its influence is a tingling in the part affected. In overdose it produces muscular rigidity, often first felt in the muscles of the neck, followed by tremblings, jerkings of the muscles, tetanic spasms, emprosthotonos, opisthotonos, etc.; in a word, the patient dies as in tetanus. The pulse and brain are, primarily, scarcely affected. Dose of powder, 3 grs. t. d.

Extractum Nucis Vomicæ. Extract.—gr. $\frac{1}{4}$–j, in pill, t. d.

Tinctura Nucis Vomicæ. Tincture. (℥iv–Oj.)—Dose, gtt. x–xx.

Strychnia.—Obtained by digesting the bean in water acidulated with muriatic acid, and precipitating with lime; then dissolving

the alkaloids out of the precipitate with boiling alcohol, evaporating, then adding sulphuric acid and boiling water, and allowing to cool and crystallize. Occurs in white powder, insoluble in cold water; very bitter. It can be crystallized. Generally contains brucia.

Test.—Bichromate of potassium and concentrated sulphuric acid cause a violet color. May be used hypodermically for paralyzed sphincters. Dose, gr. $\frac{1}{20}$–$\frac{1}{10}$.

Fig. 254.

Ergot of Rye.

Ignatia.

Seeds of Strychnos ignatia, of the Philippine Islands; an inch long, obscurely angular, on one side convex, on the other pale brown, covered with short down; internally hard, hornlike; contain strychnia and brucia. Their action on the system is the same as that of the last.

Extractum Ignatiæ. Extract.—Dose, gr. $\frac{1}{4}$.

Ergota. *Ergot.*

The diseased seeds of the Secale cereale or rye are really the mycelium of a fungus, Cordyceps purpurea, which preys on various species of Graminaceæ. Occurs in cylindrical tapering grains, an inch and more in length; curved; dark-brown externally; lighter internally; peculiar fishy odor and acrid taste. Yields to water and alcohol. Contains a fixed oil, peculiar sugar (mycose), ergotic acid; *ergotin*, *secalia* (identical with propylamin), etc. On what the action depends does not appear settled.

Therapeutics.—When taken continuously for a long time, as sometimes happens in bread, it causes dry gangrene of the extremities, probably by contracting the capillaries and thus interfering with circulation. In the ordinary dose it causes no apparent symptoms in the healthy male, but is given to check internal hemorrhage in hemoptysis, etc. It has a great influence over the uterus, as is shown by its capability of producing tonic contractions of that organ, not only in labor but during pregnancy, and even at times in the unimpregnated state. Used in unimpregnated females to check menorrhagia; during labor to produce uterine contractions. It must never be used when there is any obstacle to the passage of the child's head. Given after labor to expel clots and prevent hemorrhage by causing uterine contraction. Dose, ℈j.

Vinum Ergotæ. Wine. (℥ij–Oj.)—Dose, f℥j–ij.

Extractum Ergotæ Fluidum. Fluid Extract.—Dose, f℥j.

CHAPTER X.

ARTERIAL SEDATIVES.

MEDICINES whose principal action is upon the circulatory system, and is of a depressing nature. They lower the force and at the same time diminish the frequency of the pulse. This sedation, when marked, is always accompanied with nausea and general relaxation. A number of these medicines are very limited in their powers; they diminish the capillary circulation and produce a coolness of the surface, and that is all; these are the so-called *refrigerants*. The more powerful arterial sedatives are employed in acute inflammations; the refrigerants are given in fever.

Antimonium. *Antimony.*

The salts of this metal are powerful arterial sedatives, and their chief use is as such; but they are also used as alteratives in doses too small to produce any immediate symptoms, and in larger doses as emetics. The salt to be preferred as a sedative and emetic is tartar emetic; as an alterative, one of the sulphurets; all of them stimulate the secretions generally, and when locally applied are irritants.

Antimonii et Potassii Tartras. Tartar Emetic.—Made by boiling the oxide of antimony in solution of tartaric acid. Found in shops in white powder; crystallizes in efflorescent rhombic octohedrons or tetrahedrons. Taste, metallic, styptic, nauseous; soluble in water, insoluble in strong alcohol.

Incompatibles.—Alkalies and their carbonates, and tannic acid.

Therapeutics.—A very powerful arterial sedative, and, in very minute, long-continued doses, an alterative, as which it is sometimes used in chronic skin diseases, chronic rheumatism, etc., in $\frac{1}{20}$ grain doses. Its sedative action is usually attended with increase of most of the secretions. Given in small doses, in febrile conditions of the system, it lowers the force of the circulation, causes perspiration and gently relaxes the system. For this purpose it may be given in $\frac{1}{12}$ grain doses. It is also expectorant, and is therefore often used in the dry stage of bronchitis. In pneumonia it has been given in much larger doses, following the *contro-stimulant* treatment of Rasori, as a substitute for bleeding. He administered as much as six or eight grains in the twenty-four hours; but this plan is very rarely practised at present, as the results are not very satisfactory. In doses of $\frac{1}{4}$ to a grain, tartar emetic acts as a powerfully depressant emetic, causing violent and prolonged vomiting, with excessive nausea and prostration, and frequently purging. Repeated large doses are capable of producing death; the symptoms are, violent vomiting and purging of matters closely simulating "rice-water discharges," burning pain in the stomach, violent cramps in the bowels and limbs, great prostration; in a word, the symptoms of Asiatic cholera. The treatment must meet the indications; opiates, demulcents, external and internal stimulants, etc. After death, signs of inflammation of the bowels and stomach will be found. Great care must be exercised in giving tartar emetic to children, as they are especially susceptible to its inordinate effects; also to the aged.

Vinum Antimonii. Antimonial Wine (gr. ij–℥j).—Dose, as an expectorant or diaphoretic, gtt. xx–f℈ss. As an emetic, f℈iij–f℥ss. It is a very harsh emetic.

Unguentum Antimonii (℈ss–℥ij lard).—When antimony is repeatedly rubbed upon the skin it acts as a peculiar, powerful irritant, producing a copious, very painful pustular eruption. It is sometimes used as a counter-irritant in chronic inflammations of internal viscera, especially the lungs.

Antimonium Sulphuratum. Sulphurated Antimony.—A reddish-brown insoluble powder.

Antimonii Oxysulphuretum. Oxysulphuret of Antimony. Kermes Mineral.—A purplish-brown powder. These preparations

Fig. 255.

Fig. 256.

Fig. 257.

VERATRUM VIRIDE.

are essentially the tersulphuret of antimony, with a variable proportion of the teroxide. Their uncertain constitution renders the effect of a single large dose equally uncertain. They are scarcely ever used except as alteratives. Dose, as emetic, gr. x–xx; as alterative, gr. ij.

Pilulæ Antimonii Compositæ. Compound Pills. Plummer's Pills.—Sulphurated antimony, Calomel, āā gr. ss; Guaiac, Molasses, āā gr. ij, in a pill. Used as an alterative in chronic rheumatism, scaly skin affections, etc., especially when there is a syphilitic taint. Dose, 1–2 pills, t. d.

Veratrum Viride. *American Hellebore.*

The root of the Veratrum viride, which grows in moist places in the United States. A rhizome an inch or so in length, with numerous rootlets, often very much broken or in slices. Taste bitter and permanently acrid; contains *veratria*, but does not depend upon it for medical properties; its active principle has not been thoroughly isolated.

Therapeutics.—A powerful arterial sedative, reducing remarkably the frequency and force of the pulse. In full doses it causes vomiting, but may be so managed as to reduce the force of the pulse without much sickness at the stomach. It increases all the secretions. Symptoms of its poisonous action are prolonged and violent retching, an almost imperceptible pulse, cold, clammy skin, imperfect vision, a syncope-like condition of the cerebral faculties. Used in the dry stage of acute inflammations, especially of the lungs: also to control an excitable heart; never given in substance. When the preparations are exhibited, the patient must be carefully watched to guard against inordinate effect. Symptoms of poisoning by it must be met by free external and internal stimulation, and opiates in moderate doses.

Tinctura Veratri Viridis. Tincture (℥viij–Oj).—A saturated preparation. Dose, gtt. iij–v, repeated every hour or two until some effect is produced.

Extractum Veratri Viridis Fluidum. Fluid Extract.—Dose, gtt. i–iij, every hour or two until some effect is apparent.

Sabadilla. *Cevadilla.*

The seeds of Veratrum sabadilla. About one-fourth of an inch long, blackish-brown, curved, blunt on one side. Used only in the manufacture of the alkaloid *veratria*, which is obtained by first making an alcoholic extract, out of which the alkaloid is dissolved by means of water containing sulphuric acid; this solution of the sulphate is precipitated by magnesia; the alkaloid is purified by solution in alcohol, passage through animal charcoal, reconversion into the sulphate, and precipitation by ammonia. Veratria is a pale gray powder; of a bitter, acrid, tingling, burning taste; odorless, but excessively irritant to the nostrils.

Test.—Becomes intensely red by contact with concentrated sulphuric acid. Insoluble in water, freely soluble in chloroform, sparingly so in alcohol.

Therapeutics.—A virulent poison; used only externally, as a

local anodyne application in neuralgia; causes a burning, tingling sensation and also numbness.

Unguentum Veratriæ. Ointment (gr. xx–ʒj lard).

Gelsemium. *Yellow Jessamine.*

The root of Gelsemium sempervirens. A nervous and arterial sedative, promoting perspiration, without nausea or cathartic action. In overdoses it produces dangerous prostration; being said to have caused death in at least one instance.

Therapeutics.—It has been used in pneumonia, pleurisy, and some other diseases. The *tincture* is preferred (℥iv of fresh root in Oj of diluted alcohol). Dose, 20 to 40 drops. It is employed by some physicians as a hypnotic in cases of sleeplessness.

REFRIGERANTS.

Potassii Nitras. *Nitrate of Potassium. Nitre. Saltpetre.*

Obtained from soil containing it, which is found in India, Kentucky, etc.; also made in *nitre-beds.* Occurs in odorless, six-sided transversely striate crystals, with dihedral summits; taste cooling, saline; soluble in water, not in strong alcohol; melts and decomposes with increasing heat; deflagrates when thrown on the fire.

Therapeutics.—A gastro-intestinal irritant when given in large quantities; solid or in concentrated solution, causing vomiting and purging, and even inflammation. When given largely diluted in some mucilaginous fluid it does not affect the stomach and bowels, but reduces the circulation and temperature of the body. It is thought also to act as an antiplastic, reducing the fibrin in the blood, and lessening the tendency to the production of coagulable inflammatory exudations. If the patient be kept cool, it acts as a sedative diuretic; if he be kept warm in bed, as a diaphoretic. Used in inflammatory fevers, acute rheumatism, etc.; very often combined with tartar emetic; sometimes with calomel, or with both in the *nitrous powders*, which are used in sthenic fevers with bilious symptoms. Dose, gr. v–x, every hour or two, in weak solution.

Acidum Citricum. *Citric Acid.*

Exists in limes, tamarinds, lemons, and many other fruits. It is obtained from lemon juice, by adding chalk and decomposing the citrate of calcium formed, by dilute sulphuric acid. Occurs in transparent rhombic crystals of sour taste, freely soluble in water.

Test.—Gives no precipitate with potassa, as tartaric acid does.

Therapeutics.—A mild refrigerant.

Limonis Succus. Lemon Juice.—Is an excellent refrigerant, acting also mildly on the liver and kidneys; also a very good antiscorbutic. Given in large doses in scurvy, jaundice, and acute rheumatism; also much used as refrigerant drink.

Artificial Lemon Juice is made: Citric acid, ʒixss; water, Oj; oil of lemon, gtt. iv. Not to be relied on as a substitute in serious diseases. Lemon juice may be preserved by concentrating it by boiling or freezing; or better by the addition of sugar, as in *Syrupus limonis*, U. S.

Acidum Tartaricum. *Tartaric Acid.*

Exists in the grape and other fruits. Obtained from bitartrate of potassium. Crystallizes in irregular, six-sided prisms; usually kept in shops as a white powder. Freely soluble in water and alcohol.

Therapeutics.—Similar to citric acid. Most of its salts are aperient. Used in various effervescing powders (Seidlitz, etc.).

Acidum Aceticum. *Acetic Acid.*

The product of the acetous fermentation of alcohol, also of the destructive distillation of wood. Exists in vinegar (Acetum, U. S.). A colorless, very sour liquid with a pungent odor. Sp. gr. 1.047.

Therapeutics.—The strongest glacial acetic acid is corrosive, and is employed as a caustic in warts, etc. When sufficiently diluted, refrigerant, diaphoretic, and diuretic.

Acidum Aceticum Dilutum. Dilute. (Oj–Ovij water.)—About the strength of vinegar. Sp. gr. 1.006.

CHAPTER XI.

NERVOUS SEDATIVES.

MEDICINES which produce a marked diminution of nervous power, and affect at the same time the sensorium and circulation. In overdoses they are all of them active poisons, capable of producing fatal results. They are used in diseases of nervous and vascular excitement.

Digitalis.

The leaves of the Digitalis purpurea or Foxglove, a biennial plant, which produces in the second year a long, handsome spike of large and very beautiful purplish flowers. The leaves should be gathered directly after flowering, dried with care, and preserved so as to exclude the light. They should be of a fine green color, and possess the peculiar bitter taste in a well-marked degree. Their active principle is *digitalin*, which is white, inodorous, intensely bitter; it gives with concentrated muriatic acid an emerald-green color.

Therapeutics.—Powerfully sedative to the circulation, and narcotic; causes, in full dose, great reduction in frequency and force of the heart's action, with vertigo, dimness of vision, a sense of tightness in the head, confusion of intellect; it is also powerfully diuretic. In poisonous doses, these symptoms are aggravated, with vomiting, hiccough, cold sweats, convulsions, and death from syncope. Its action is cumulative, and must be carefully watched. Used chiefly to control the heart's action in various organic diseases of it, in aortic aneurism, and in various inflammations, although

in the latter its action is too slow. As a diuretic, in dropsy. Dose, gr. ss–ij, in pill t. d.; of digitalin gr. $\frac{1}{50}$ every three hours.

Fig. 238.

DIGITALIS PURPUREA.

Infusum Digitalis. *Infusion.* (ʒj–f℥ix.)—Dose, f℥ss.
Tinctura Digitalis. *Tincture.* (℥ij–Oj.)—Dose, gtt. x–xx.
Extractum Digitalis. *Extract.*—Dose, gr. $\frac{1}{4}$, in pill.

Potassii Bromidum. *Bromide of Potassium.*

Prepared by adding bromine and iron, and afterwards potass. carb., to distilled water, with gentle heat. It occurs in white crystals, soluble in water, sparingly so in alcohol. It is not precipitated by chloride of barium. With nitrate of silver, its solution forms a yellowish precipitate; and with starch and chlorine water, it becomes yellow.

Therapeutics.—Bromide of potassium appears to lessen reflex excitability, either through its influence upon the spinal cord and sensorial ganglia of the brain, or by reducing the sensibility of the peripheral terminations of the nerves. It diminishes sexual appetite, and renders the larynx and fauces less irritable under the use of the laryngoscope. Much use has been made of it in the treatment of *sleeplessness* from nervous irritability; and it is the favorite medicine with many physicians for *epilepsy.* Dose, v to xx grains, two or three times a day.

Bromide of Ammonium is officinal. In physical properties and

physiological effects, it resembles the bromide of potassium to a considerable extent. It has been given especially in *rheumatism* and *hooping-cough.* The *bromides of calcium* and *lithium* have also been used for similar indications to those above mentioned. Too long continuance of any of the bromides in large doses may produce *bromism;* a peculiar state of debility, with an eruption upon the skin.

Tabacum. *Tobacco.*

The leaves of the Nicotiana tabacum, an annual plant, originally a native of tropical America, cultivated throughout the warmer portions of the world. When dried, color yellowish-brown ; taste, bitter, acrid ; odor, narcotic, strong. Yields to water and alcohol. Contains *nicotia* or *nicotin*, an alkaline, volatile, oily, colorless, extremely poisonous liquid ; odor, that of tobacco ; taste, acrid. By destructive distillation tobacco yields also a very poisonous empyreumatic oil, having the odor of old tobacco-pipes.

Therapeutics.— A powerful nervous and arterial sedative, rapidly producing, in those unaccustomed to its use, great nausea and vomiting, great muscular relaxation, feeble pulse, vertigo, stupor, cold, clammy skin, convulsions and death from syncope. Formerly used in enemata as a relaxant in strangulated hernia, etc., but at present rarely used as such, unless in obstinate spasm of the bowels and urethra. A very dangerous remedy.

Infusum Tabaci. Infusion (ʒj–Oj).—Dose, Oss.

Vinum Tabaci. Wine (℥j–Oj).—Dose, gtt. x–xx.

Unguentum Tabaci. Ointment (℥ss–℥viij).—Used as a local anodyne. Must be cautiously employed.

Aconiti Radix. *Aconite Root.* **Aconiti Folia.** *Aconite Leaves.*

Root and leaves of the Aconitum napellus, or monkshood, a plant of the buttercup family, distinguished by its helmet-shaped, dark-blue flowers ; a native of Europe. Root tapering ; leaves many parted ; taste bitterish, acrid, followed by a peculiar prickling sensation all through the mouth, with numbness. Contains the alkaloid *aconitia* in combination with *aconitic acid.*

Therapeutics.—A powerful nervous sedative and anodyne. In full doses it lessens the pulse, causes a universal prickling tingling sensation, numbness, diminished sensibility, with great muscular weakness. In overdoses an exaggeration of these symptoms, with burning in the throat, distressing vomiting, excessive prostration, and death from syncope. Coma or convulsions rarely occur. When locally applied it produces marked burning and tingling followed by numbness. It is much employed as a local anodyne. Internally, it is given to reduce the pulse, and as an anodyne.

Tinctura Aconiti Foliæ. Tincture of Aconite Leaves.—Dose, gtt. xx–xxx. Must be distinguished from

Tinctura Aconiti Radicis. Tincture of Aconite Root.—Dose, gtt. ij–v. Much used locally.

Extractum Aconiti. Extract.—Dose, gr. j. *Aconitia*, sparingly soluble in water, freely in alcohol and ether ; one of the most virulent poisons known, $\frac{1}{40}$ gr. probably enough to destroy life. Dose,

Fig. 259.

ACONITUM NAPELLUS.

$\frac{1}{300}$ gr. Used externally as a local application in neuralgia, etc., in the form of ointment (gr. j–ʒj lard).

Acidum Hydrocyanicum Dilutum. *Dilute Hydrocyanic Acid.*

Prussic Acid is formed of the radical cyanogen united with hydrogen, and is developed in many plants belonging to the prunus or plum family (see Prunus Virginiana). The concentrated acid is a colorless fluid, sp. gr. 0.697, of a peculiar, strong odor, so poisonous that a fraction of a drop may cause death. It is extremely volatile, and has a great tendency to undergo decomposition. The officinal acid contains but two per cent. of prussic acid in water; it possesses the properties of the strong acid, only in a less degree. It is obtained by the action of dilute hydrochloric acid on cyanide of silver, or of dilute sulphuric acid on ferrocyanide of potassium. It must be excluded from the light, as that agent rapidly decomposes it.

Therapeutics.—In moderate doses causes a feeling of sinking, with vertigo, without very marked alteration of the heart's action.

In overdoses excessive and instantaneous prostration, giddiness, faintness, tetanic convulsions, with insensibility and death. When taken in large amount, the patient may fall almost as if struck by lightning. There is nothing revealed by *post-mortem*, except that there is nearly always a marked odor of the acid. In cases of poisoning, if there be time, chlorine and ammonia should be exhibited, and cold and hot water alternately be dashed over the body. Internally, used as an anodyne in *gastrodynia;* as a nervous sedative in various nervous and even organic coughs, as hooping-cough, phthisis, etc.; also as an anti-emetic in sick stomach. Dose, gtt. i.

Potassii Cyanidum. Cyanide of Potassium.—May be used instead of the acid, as it is decomposed, and the acid is formed by the free hydrochloric acid in the stomach; very poisonous. Dose, gr. $\frac{1}{8}$–$\frac{1}{6}$.

Physostigma Venenosum. *Calabar Bean.*

This is the fruit of a creeping plant of Western Africa. It is used by the negroes as an ordeal to test the guilt or innocence of accused persons. The shell is said to act as a purgative. The bean, when taken in large quantities, is a powerful depressant poison, 15 grains of the kernel having produced death within an hour.

Therapeutics.—Calabar bean is best known for its action upon the iris, causing contraction of the pupil; the opposite action to that of belladonna, atropia, etc. By an influence upon the ciliary muscle of the eye, it also alters the accommodation of vision, inducing temporary near-sightedness. It has a limited application in ophthalmic surgery. Internally administered, it is thought by some physicians to act beneficially in *tetanus*, and in *chorea*. Dose, of the kernel, 1 or 2 grains; of the tincture, 5 to 10 drops. For dropping into the eye, an extract or strong infusion is employed; a very little being sufficient for the effect.

CHAPTER XII.

ALTERATIVES.

These are medicines which, without producing any marked symptoms, gradually alter the nutrition of diseased organs or tissues so as to permit healthy action and structure to replace diseased action and structure. Their action is characterized by its slowness and insidiousness, so to speak, and is very hard to explain; but it is not the less certain and real. That these medicines are capable of influencing the nutrition of the body, is shown by the circumstance that the more powerful of them, when pushed too far, or for too long a time, induce wasting and emaciation.

Hydrargyrum. *Mercury.*

This metal has been sometimes used in large quantities as a mechanical remedy to overcome intussusception and other obstructions in the bowels. When given in a finely divided state, it is oxidized and worked up into a soluble salt by the acids of the stomach, and even the most insoluble salts, as calomel, are dissolved in the liquids of the alimentary canal. Mercury may be also introduced either by the lungs or skin; mercurial inunctions were greatly in vogue in the days of heroic salivation. The effect of breathing mercurial fumes is seen in the poisoning of artisans who work in the metal. That mercury is absorbed is proven by the fact that it has been detected both in the solids and liquids of the body. The effects of it upon the system may be conveniently stated under two heads:—

First, its effect upon the alimentary canal and its appendages. Secondly, the general alterative or the constitutional effects of it in small doses continuously taken. That many of the mercurial preparations are decided cholagogues admits of no doubt, upon clinical evidence; notwithstanding the contradictory results of Bennett's and Röhrig's experiments with them upon animals. The former asserts that, in dogs, calomel does not increase the flow of bile; the latter, that it does. They probably at the same time augment all the various secretions of the alimentary canal. In congestion of the liver, in functional disorder of the digestive organs with scanty, dry, light clay-colored stools, they are invaluable. They are also useful where the engorged liver is secreting a morbid, acrid bile, causing dark liquid stools. As an alterative, where mercury is given in small doses frequently repeated, one of its first actions is to augment all the secretions of the body; and it is this first degree of operation that sometimes makes its use desirable in the earliest stage of a *fever*, when there exist a dry tongue, torpid bowels, and a general scantiness of the secretions. It is also used for this purpose in some *chronic skin* diseases, connected with a disordered state of the alimentary canal. In these affections, especially in the fevers, great care must be taken not to push it too far.

When continued for a longer time, or given more freely, mercury acts as a true alterative; modifying to a greater or less extent the nutrition of the whole body, and in some cases apparently acting as an antidote to a poison existing in the system. It seems to influence the diseased, sooner and more strongly than the normal structures. This action on the nutrition of a part is seen in the diminution of glandular indurations and swellings by it. As an instance of its specific, antidotal action, may be mentioned its curative powers in *syphilis*. When mercury is exhibited very freely it produces a train of symptoms known as *ptyalism* or *salivation*, accompanied by an alteration of the blood, followed by rapid emaciation and loss of strength. The first sympt•ms of ptyalism are red, swollen gums, with soreness of the teeth, especially felt when they are firmly closed; a peculiar, disagreeable fetor of the breath, and a coppery, metallic taste in the mouth. In aggravated cases, to an exaggeration of these symptoms, are

added a very great flow of saliva, with swelling and irritation of the salivary glands, and in bad cases even gangrene of the tissues of the mouth, necrosis of the jaw-bone, with permanent disfiguration for life, or even death from exhaustion. The treatment of this affection consists in the use of local astringent and detergent applications, opium in small doses, and general support. Mercury has been frequently used to an extent short of salivation in acute sthenic inflammations, especially of the serous membranes, as antiphlogistic and antiplastic. The use of mercury is strongly contraindicated by the existence of any marked cachexia, or of the scrofulous diathesis, or whenever the system is broken down by long-continued disease.

Unguentum Hydrargyri. Mercurial or Blue Ointment.—Made by rubbing mercury with an equal weight of lard and suet till it is extinguished, *i. e.*, disappears from sight. A soft, bluish ointment, used as a local or constitutional alterative.

Emplastrum Hydrargyri. Mercurial Plaster.—Made by rubbing up mercury, oil, and melted rosin, and adding melted lead-plaster; used to disperse glandular swellings, etc.

Pilulæ Hydrargyri. Blue Pill. Mercurial Pill. Blue Mass.—Made by rubbing up mercury with confection of roses and powdered liquorice root until extinguished. Each pill is three grains in weight, and contains one grain of mercury. Used as alterative or sialagogue, one pill t. d. or less; as a cholagogue purgative, two to four pills, followed if required by Seidlitz powder or similar purgative.

Hydrargyrum cum Creta. Mercury with Chalk.—Made by extinguishing (by rubbing up) mercury ℥iij in prepared chalk ℥v. A gray powder; chalky taste; odorless. Employed as an alterative and antacid, especially in the bowel complaints of children. A mild preparation. Dose, gr. j–x, t. d.

Hydrargyri Chloridum Corrosivum. Corrosive Sublimate. Mercuric Chloride.—Made by first making a bisulphate by action of dilute sulphuric acid on mercury, then subliming this with salt. In colorless, crystalline masses; fusible and sublimable by heat; soluble in water, ether, and alcohol. Taste, metallic, styptic, disagreeable. Lime-water throws down from its solution a reddish-yellow precipitate (deutoxide). A very irritant, corrosive poison—antidote, albumen. Used as an alterative in tertiary syphilis, not apt to salivate. Dose, gr. $\frac{1}{12}$–$\frac{1}{8}$. Used in solution as a local alterative and stimulant to ulcers, especially venereal.

Hydragyri Chloridum Mite. Calomel. Mercurous Chloride.—Made by adding more mercury to the bisulphate, and then subliming with salt, and washing the sublimate to free it from any of the bichloride that may be formed. A whitish, insoluble, tasteless, heavy powder; with lime-water yields black precipitate (mercurous oxide). *Incompatibles* of both chlorides, alkalies, alkaline earths. Used as alterative or sialagogue in $\frac{1}{2}$–1 gr. doses, every three hours or oftener; as a cholagogue purgative, dose, gr. v–x.

Hydrargyri Oxidum Rubrum. Red Oxide of Mercury. Red Precipitate.—Mercuric oxide, chiefly used as *yellow wash.* (2 grs. corrosive sublimate, f℥j lime-water.) And in *unguentum* as a local stimulant and alterative.

Unguentum Hydrargyri Oxidi Rubri. Red Precipitate Ointment. (ʒj–℥j.)

Hydrargyri Oxidum Flavum. Yellow Oxide of Mercury.—This is prepared by mixing solution of corrosive sublimate with solution of potassa, washing, and drying. It is chemically identical with the red oxide, but more finely divided.

Hydrargyri Iodidum Viride. Green Iodide of Mercury.—Made by rubbing together with alcohol, mercury ℥j, iodine ʒv. Greenish-yellow powder; insoluble in water and alcohol. Used in secondary syphilis. Dose, gr. j.

Hydrargyri Iodidum Rubrum. Red Iodide.—A biniodide. Made by treating iodide of potassium with corrosive sublimate. Brilliant red powder; insoluble in water, soluble in alcohol and solution of iodide of potassium; volatilizable; very acrid and poisonous. Used in secondary and tertiary syphilis. Dose, gr. $\frac{1}{16}$; also used as a local stimulant and alterative in skin affections.

Hydrargyrum Ammoniatum. Ammoniated Mercury. White Precipitate.—Obtained by precipitating a solution of bichloride with solution of ammonia; white, insoluble powder; irritant and poisonous. Used as a local stimulant alterative in chronic skin affections. Not internally.

Unguentum Hydrargyri Ammoniatum. Ointment. (gr. xj–℥j.)

Unguentum Hydrargyri Nitratis. Ointment of the Nitrate of Mercury. Citrine Ointment.—Made by action of nitric acid on mercury, neats-foot oil, and lard. A fine citron color when fresh; spoils by keeping: much used as a powerful stimulant alterative; must often be much diluted with lard.

Besides these the following preparations are officinal, but very rarely seen: the *yellow sulphate of mercury* (turpeth mineral), a yellowish, acrid powder; the *black sulphuret* (ethiops mineral); the *red sulphuret* (cinnabar, vermilion). Used only for fumigation.

Iodinium. *Iodine.*

An elementary, non-metallic solid, of a bluish-gray color and metallic lustre, emitting violet fumes when heated; odor peculiar; sparingly soluble in water, freely in alcohol. Iodine in large doses acts as an irritant, corrosive poison. In small doses its action seems to be at first somewhat tonic, whilst there is at the same time more or less increase of most of the secretions. It seems to stimulate nutrition; this is especially seen in the emaciation of the scrofulous cachexia. When taken for too long time it perverts the normal functions and causes emaciation and wasting, with marked symptoms of disorder of the digestive and nervous systems. Its great use is in the treatment of the numerous forms of scrofulous disease, glandular swellings, ophthalmia, abscesses, etc. It is also frequently exhibited with advantage in tertiary syphilis, chronic skin affections, chronic rheumatism, etc. In goitre, it is the most efficient known medicine, and should be used both internally and externally. It is not given in substance. When used externally it acts as a stimulant and alterative to the skin, and is much used in the form of the tincture, in various skin diseases, erysipelas, frost-bite, lupus, etc. When applied in this way it appears to be absorbed, and to exert a marked alterative and discutient influence on the

neighboring tissues. It is therefore applied over diseased joints, various tumors, glandular swellings, dropsical bursæ, etc.

Tinctura Iodinii. Tincture. (℥j–Oj.)—When long kept this is decomposed, with formation of ioduretted ethers. It is rarely given internally; may be used in 10–20 drop doses, in sweetened water; externally should be applied with a camel's hair brush.

Unguentum Iodinii. Ointment. (Iodine gr. xx, iodide of potassium gr. iv, lard ℥j.)

Unguentum Iodinii Compositum. Compound Ointment. (Iodine gr. xv, iodide of potassium ʒss, lard ℥j.)—Used, as also the last, in chronic indurated glandular swellings.

Tinctura Iodinii Composita. Compound Tincture. (Iodine ℥ss, iodide of potassium ℥j, alcohol Oj.)—Dose, gtt. x–xx.

Liquor Iodinii Compositus. Compound Solution. Lugol's Solution. (Iodine ʒvj, iodide of potassium ℥jss, water Oj.)—In this preparation advantage is taken of the solvent power of a solution of iodide of potassium. The favorite preparation for internal use. Dose, gtt. vj–xxx, t. d. The *iodide of sulphur* is officinal; used as a local stimulant and alterative in skin affections.

Potassii Iodidum. *Iodide of Potassium.*

Made by adding iodine to a boiling solution of potassa. Occurs in white, cubical, slightly deliquescent crystals; very soluble in water and alcohol; taste saline, acrid; its aqueous solution can dissolve iodine.

Therapeutics.—Its action on the system is similar to but not identical with that of iodine; used in chronic rheumatism, tertiary syphilis, etc. Dose, gr. v–xv, t. d., in watery solution, or in compound syrup of sarsaparilla. It should be taken after meals, as it is when thus given less liable to cause disorder of the digestive apparatus.

Arsenicum. *Arsenic.*

A metallic substance, which is in itself inert, but when oxidized or in the state of a soluble salt is very poisonous. There are two oxides, arsenious acid, and arsenic acid, the latter of which is the most soluble, but is rarely seen. The arsenical preparations, in very small doses, seem to act as tonic alteratives, increasing the "embonpoint" and clearing the skin. If the doses be a little too large, there will be caused a puffiness and dropsical swelling of the face, especially about the eyes. When too long continued, a peculiar cachexia is produced, with wasting, emaciation, etc. In large doses, they act as powerful corrosive poisons, causing violent inflammation or rapid destruction of the stomach and bowels. The symptoms of arsenical poisoning are, burning pain in the throat, stomach, and even bowels, incessant vomiting of acrid matters; epigastric tenderness, great thirst, purging, with nervous prostration, collapse, death. Antidotes, *freshly precipitated hydrated sesquioxide of iron*, which forms an insoluble arsenite of iron; also freshly calcined magnesia, white of eggs, milk, and other demulcents. Arsenic is, next to cinchona salts, the most largely employed antiperiodic, especially useful where the latter

fail. Given as an alterative in chronic skin affections, chronic rheumatism, nodes, etc.

Acidum Arseniosum. Arsenious Acid.—In crystalline masses, vitreous fracture, at first transparent, afterwards milk-white. Dose, gr. $\frac{1}{16}$–$\frac{1}{12}$, t. d., in solution. Externally, a powerful caustic, used in cancer, etc. Care must be taken that it does not produce constitutional symptoms by its absorption.

Liquor Potassii Arsenitis. Solution of Arsenite of Potassium. Fowler's Solution.—Made by boiling arsenious acid and bicarbonate of potassium, āā gr. 64 in water f℥12, and adding compound spirit of lavender, f℥ss, and water enough to make a pint. Much used as an alterative. Dose, gtt. iij–viij.

Liquor Arsenici et Hydrargyri Iodidi. Solution of the Iodides of Arsenic and Mercury. Donovan's Solution.—A very powerful alterative. In large dose a corrosive poison; capable of causing ptyalism. Dose, gtt. ij–v.

Sodii Hyposulphis. *Hyposulphite of Sodium.* **Sodii Sulphis.** *Sulphite of Sodium.*

The hyposulphite has large, colorless, transparent crystals, with a bitter, sulphurous taste. It is quite soluble in water, but insoluble in alcohol. It bleaches solution of iodine, or of iodide of starch.

Therapeutics.—Professor Polli, of Milan, introduced the use of the *sulphites* and *hyposulphites* of sodium, calcium, and magnesium, because of their *antiseptic* (preservative) and *anti-zymotic* (opposed to fermentative) action. The idea is attractive, but has met, in practice, with but limited success. In *dyspepsia*, with the presence of *sarcinæ* in the stomach, the sulphite of sodium appears to be serviceable. It has been applied *externally*, in erysipelas. Dose, internally, ʒj thrice daily; for local application, ʒj to ℥j, dissolved in water. The other sulphites and hyposulphites may be given or used in a similar manner; the doses being generally *half as large* for the sulphites of calcium and magnesium as for the sulphite of sodium.

Acidum Carbolicum. *Carbolic Acid. Synonyms, Phenic Acid, Phenylic Alcohol, Carbol.*

This substance is obtained in the distillation of coal-tar, at a temperature between 300° and 400° F. When *pure*, it occurs in needle-like crystals, or in crystalline masses, white or colorless, which redden on exposure to the air. It is quite deliquescent. Odor and taste, strong and disagreeable. Fusing point, about 100°; boiling, 360°. It dissolves in 20 or 30 parts of water; also freely, in alcohol, ether, glycerin, alkalies, and essential oils. *Impure* carbolic acid contains cresylic acid, oil of tar, and other impurities derived from coal-tar. It is a liquid, generally of a reddish-brown color. This is quite available as a *disinfectant.*

Therapeutics.—Carbolic acid has been proposed, like the sulphites, as an *antiseptic* remedy, in various zymotic diseases; as *pyæmia*, *scarlet fever*, etc. Dose, 1 grain, in a fluidounce of water.

As a gargle, in malignant diphtheria or scarlatina, 1 or 2 grains in a fluidounce of water. Externally, 15 grains in an ounce of

water, or 1 part to 20 of olive oil. Dr. Bill, U. S. A., has pointed out the fact that carbolic acid (although *caustic* to the skin, like creasote, when pure) is a powerful *local anæsthetic.* With oil or glycerin, it has been found to give relief, when applied to the part affected, in *neuralgia.*

The *glycerite* (or glycerole) of carbolic acid is officinal, U. S. P. This, as well as a watery solution, is sometimes useful in skin diseases; especially those of a parasitic kind.

Aqua Acidi Carbolici is also officinal. It is made by mixing the glycerite with distilled water (f℥x in Oj).

Potassii Chloras. *Chlorate of Potassium.*

A colorless salt, in tabular crystals, with a pearly lustre; soluble in water. It yields no precipitate with nitrate of silver. When strongly heated, it gives off oxygen. Sulphuric acid, dropped on the crystals, makes them first yellow, and then red. Taste, saline, not very disagreeable.

Therapeutics.—Chlorate of potassium is the most valuable of alteratives in the treatment of *ulcerative sore mouth.* It is also often very serviceable in *diphtheria.* Dose, gr. x–xx.

CHAPTER XIII.

EMETICS.

THESE are medicines which excite vomiting. Emesis takes place principally through the action of the diaphragm and abdominal muscles, although probably the muscular tissue of the stomach also performs a part. These muscles are excited into action through the various motor nerves which supply them. The action, then, of an emetic is directly or indirectly upon the nerve centres that supply these muscles. Emetics are divisible into two sets: those whose action is necessarily preceded by their absorption into the blood, and which probably act on the nerve centres only by immediate contact; and those which irritate the mucous membrane of the stomach, and cause vomiting by a reflex action. The latter class produce very little nausea and depression; they are the so-called *mechanical* or *stimulating* emetics, and are used simply to evacuate the stomach, to dislodge mechanically substances in the trachea or bronchi, and to arouse or shock the system. All emetics acting through the blood produce more or less nausea and depression. They are the depressing emetics, and are used to produce muscular relaxation; to lessen arterial excitement and to overcome the dry stage of inflammatory action; to deplete, to increase secretion, etc. All emetics, especially the harsher, must be avoided if possible in pregnancy, congestion of the brain, inflammation of stomach, and hernia. The susceptibility of the stomach to the influence of emetics is increased by most diseases of the

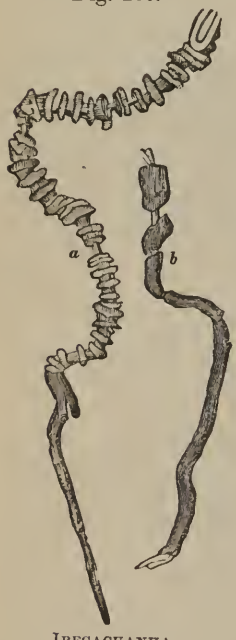
organ, and lessened by many nervous diseases, markedly so by the stupefaction of narcotics.

VEGETABLE EMETICS.

Ipecacuanha.

The root of the Cephaelis ipecacuanha of Brazil; several inches long, very much contorted, marked with a series of prominent transverse rings (hence often called *annulated ipecac*), about as thick as a small quill. The color varies, so that there are three varieties, *brown*, *red*, *gray*. It consists of two parts; the outer, the cortex, is thick, hard, horny, brittle, with a somewhat resinous fracture; it contains all the virtues; the inner portion is woody and inert. The fawn-colored powder is an irritant to the mucous membrane of the respiratory system, and causes, when inhaled, sneezing, and in some, fits of spasmodic asthma. The active principle is an alkaloid, *emetia*, which exists in combination with *ipecacuanhic acid*, one of the tannic acid series.

Fig. 260.



IPECACUANHA.

Therapeutics.—In very small doses (gr. ss), it acts as a stimulant to the mucous membrane of the stomach, and has been used as an anti-emetic; in rather large doses an alterative (gr. j–ij) and stimulant of the secretions, especially of the lungs and skin. As an emetic, its action is mild, prompt, and certain, accompanied with little depression. If its emetic action be restrained by opium, it acts as a cholagogue cathartic. Dose, as an emetic, gr. xx; as a sedative, in bilious dysentery, gr. v–x every two hours or oftener. Dose of emetia as emetic, gr. $\frac{1}{4}$–ss.

Vinum Ipecacuanhæ. Wine (℥j–Oj).—Dose, f℥ij–f℥ss as an emetic, gtt. xx–fʒss as an expectorant. Used chiefly as expectorant.

Extractum Ipecacuanhæ Fluidum. Fluid Extract.—Contains acetic acid. Dose, as an emetic, fʒss.

Lobelia.

The herb of the Lobelia inflata, an indigenous annual. Taste at first slightly, afterwards persistently acrid. Contains a peculiar liquid alkaloid, *lobelina*, in which the narcotic but probably not the emetic properties reside.

Therapeutics.—A powerfully depressant emetic, with narcotic and expectorant properties, capable of producing death. Its action

resembles that of tobacco, hence its name, *Indian tobacco.* In overdoses, causes distressing vomiting, with great prostration and muscular relaxation, headache, tremors, convulsions, and death from paralysis of respiratory muscles. Rarely used as an emetic, but as a narcotic expectorant in *asthma* and allied diseases.

Tinctura Lobeliæ. Tincture (℥ij–Oj).—Dose, as emetic, f℥j; as expectorant, gtt. x–xx.

Acetum Lobeliæ. Vinegar (℥ij–Oj).—Dose, same.

Fig. 261.

Lobelia Inflata.

Besides these, the following indigenous emetics are officinal: Roots of *Euphorbia ipecacuanha* and *E. corollata*, very harsh, irritant, and at the same time uncertain emetics, rarely used. Roots of *Gillenia stipulacea* and *G. trifoliata* (*Indian Physic*), which resemble in their emetic action ipecacuanha. Used in 20–30 gr. doses. Root of *Sanguinaria Canadensis*, or *Bloodroot*, distinguished by its red color, and short, truncated character; a very harsh emetic, with narcotic and expectorant properties. Seldom used; sometimes in cough mixtures. Dose, as emetic, gr. v–xx. A tincture is officinal. Emetic dose, f℥ij; expectorant, gtt. x–xx.

Squill, a harsh, stimulating emetic. *Mustard Flour*, a very valuable stimulating emetic, much used simply to evacuate the stomach, especially in narcotic poisoning. Dose, a tablespoonful, repeated every twenty minutes.

MINERAL EMETICS.

Tartar Emetic is a very powerful emetic, acting but slowly, but very surely and persistently, causing a great deal of nausea, retching, and general systemic disturbance. It has been sometimes used when the secondary effects of an emetic are desired, as, for instance,

to act on contiguous viscera, in congested liver and spleen, or to check an incipient inflammation. Dose, gr. j, repeated in half an hour, of the wine f℥ss. Its use as an emetic has come to be almost totally abandoned, on account of the violence of its action. It is particularly objectionable with young children, on this account.

The sulphates of zinc and copper are prompt, powerful, stimulating emetics; causing violent vomiting with but little nausea. They are used when the indication is simply to evacuate the stomach, or dislodge anything mechanically, as in membranous croup; especially useful in narcotic poisoning. Sulphate of copper is so irritating that it must be used with caution. Dose, gr. iij–v. Sulphate of zinc, dose, gr. xxx.

Alum is also a prompt, stimulant emetic; especially recommended in cases of croup. Dose of the powder, 1–2 teaspoonfuls every fifteen minutes, until the effect is produced.

CHAPTER XIV.

CATHARTICS.

These are medicines which produce an increase in the amount and frequency of the passage from the bowels. They operate in three ways: 1st, by stimulating the muscular coat of the bowels to augment peristaltic action; 2d, by increasing the discharge from the mucous membrane and the innumerable glands of the alimentary canal; 3d, by occasioning a greater flow of bile, which acts as a purgative; such medicines are termed *cholagogues*. When a purgative acts very violently, with a great deal of griping and pain and irritation of the mucous membrane, it is said to be *drastic*. When it produces large watery stools it is a *hydragogue*. A very mild cathartic, which merely evacuates the bowels, is a *laxative*; the more decided cathartics are *purgatives*. Cathartics differ as to the part of the alimentary canal which they affect. Thus, aloes acts almost exclusively upon the rectum and lower bowel; the saline upon the whole tract; rhubarb most powerfully on the muscular coat, etc.

Cathartics are used, 1st, to unload the bowels, as in typhus fever, colic from indigestible food, etc.; 2d, to promote secretion and relieve habitual constipation and its attendant evils; 3d, to deplete in various sthenic inflammatory diseases; the hydragogues should be selected for this purpose; 4th, to revulse; they are used for this purpose especially in disease of the brain. The amount of surface of the mucous membrane that can be irritated, enables us to set up a very powerful counter-irritation by them; the drastics should be employed for this purpose. If purgatives are required when there is inflammation of the bowels, castor oil or a mild saline should be selected. They must be used with reserve in enteric fever. Their griping is best remedied by administering with them hyoscyamus, aromatics, or small quantities of opium. Their action is often much promoted by combining several of them together. They

act most rapidly when taken upon an empty stomach. Hypercatharsis is to be checked by opiates, and sometimes stimulants.

There are a number of articles of food which are *laxatives*, and are usefully employed in habitual constipation; such are fruits, fresh or dried, and stewed, especially prunes, peaches; sugar and molasses, the latter especially useful with rye or oatmeal mush; bran, best employed in the form of *bran crackers* and *bran bread.* Many of these substances, as bran and fruits, act to a great extent mechanically, the large amount of innutritive material that they contain exciting the bowels to action: in this way a vegetable diet acts.

VEGETABLE CATHARTICS.

Tamarindus. *Tamarind.*

The preserved fruit of the Tamarindus Indica, an East Indian tree. Prepared by stripping off the hard shell, placing in bags in a cask, and pouring boiling syrup over them. Used as a laxative.

Cassia Fistula. *Purging Cassia.*

The fruit of the Cassia fistula, a native of the East Indies. Cylindrical, dark-brown pods, a foot or more in length, containing numerous seeds, imbedded in a black, sweet mucilaginous pulp, which contains sugar, gum, vegetable acids, etc. Used as a mild laxative, in confection of senna.

Manna.

The concrete juice of the Ornus Europæa, the ash of southern Europe. Obtained both by spontaneous exudation and incisions. There are three varieties: *Flake manna*, obtained in July and August when the weather is hot and dry; occurs in irregular, yellowish-white masses, several inches long, half to one inch wide, often with pieces of the bark adherent; odor, faint; taste, sweetish. The best variety. *Manna in sorts*, procured later in season, consists of tears and pieces of flakes glued together by fat manna. Its color is darker, and taste more nauseous. *Fat Manna*, obtained very late in season; irregular, soft, almost semi-fluid masses, of a dark color, nauseous taste. The poorest variety. Active principle, *mannite*, a sort of sugar incapable of undergoing the vinous fermentation.

Therapeutics.—A laxative, in large doses causing flatulence and griping. Used with senna as a laxative for children and pregnant women. Dose, ʒij–℥j.

Oleum Ricini. *Castor Oil.*

Obtained from the seed of the Ricinus communis, growing in different parts of the world. The fruit is a three-celled capsule, with an oblong, spotted, brownish seed in each cell. The seeds are a drastic purgative, owing to an acrid principle which they contain, and which may be driven off by heat. The best oil is obtained by expression. The seeds are gently warmed to liquefy the oil in them, and then subjected to powerful pressure. The oil

thus obtained is boiled with a large quantity of water, to coagulate the vegetable albumen and dissolve out mucilage and other impurities; afterwards it is boiled with a little water to drive off the acrid principle; if the oil is scorched at all in this process, it is darkened and rendered very acrid and irritating. An inferior dark variety is prepared in the East and West Indies, by roasting the seeds, mashing and boiling them in water, and skimming the oil off as it rises to the surface, and purifying as above. This variety is more acrid. Castor oil is soluble in ether and cold alcohol, and should be light colored, and entirely devoid of an acrid taste.

Fig. 262.

RICINUS COMMUNIS.

Therapeutics.—A very mild but certain cathartic; much used when it is desired simply to evacuate the bowels, especially in cases of children and pregnant women. In irritated or inflamed bowels,

as diarrhœa, dysentery, etc., it is invaluable. Dose, f℥ss–j, for an infant fʒj–ij. Given in boiling milk, hot coffee, or, better still, spiced syrup of rhubarb; or in emulsion.

Rheum. *Rhubarb.*

The root of Rheum palmatum, or other species, growing in Tartary and Central Asia, cultivated in Europe. There are three varieties: 1st, Russian rhubarb. This is the finest rhubarb; the pieces are carefully selected, and afterwards inspected at a frontier town of Russia near Tartary by a government inspector; each piece has a *hole bored into it* in order to ascertain its soundness. The pieces are irregularly cylindrical, with *angular edges*, the result of the bark being *pared* off; of a lively yellow color, variegated within; very gritty under the teeth, as it contains numerous *raphides* or crystals of oxalate of calcium; stains the saliva; odor peculiar, aromatic; taste bitter, aromatic, astringent; imported from St. Petersburg. Such of the pieces as are prepared for the Russian market, but fail to pass the inspection, find their way into commerce through Constantinople, and are known as *Turkey* rhubarb, inferior to Russian, superior to the Chinese. Russian rhubarb is not at present in the market.

Fig. 263.

Crystals of Calcium Oxalate in Russian Rhubarb.

Chinese Rhubarb.—Origin same as Russian, inferior pieces, which come through Canton. Pieces smooth and powdery on the outside, the bark having been *scraped* or *rasped* off; not so gritty as the last, nor so bright colored or aromatic; hole extending *through it*, made to hang it up to dry, often containing remains of the string.

European Rhubarb.—Occurs in various forms, often cut to imitate other varieties; texture very loose; does not tinge saliva, or feel gritty to the teeth; nearly worthless. Active principles, several resins and tannic acid.

Therapeutics.—A tonic, purgative, and stomachic; in small doses astringent; used to evacuate the bowels in dyspeptic and typhoid cases; it causes very little depletion, acting principally on the muscular coat of the intestines. In full doses apt to gripe; should not be given as a purgative alone, but combined with others. Roasting destroys its purgative, but not its astringent property. Dose, as a laxative, gr. v–x; as a purgative, gr. xx–xxx.

Infusum Rhei. Infusion. (℥ss–Oj.)—Dose, f℥ss–ij.

Tinctura Rhei. Tincture. (R. ℥iij, Cardamom ℥ss–Oj.)—Dose, fʒj–f℥ss.

Tinctura Rhei et Sennæ. Warner's Gout Cordial. (Rh. ℥j; Senna, red saunders, āā ʒij; Liquorice, saffron, fennel, coriander, āā ʒss; Raisins, ℥vj–Oiij). A stimulating stomachic and purgative. Dose, f℥ss.

Syrupus Rhei. Syrup. (Fl. extr. f℥iij–f℥xxix syrup.)—Dose, fʒss–f℥ss.

Syrupus Rhei Aromaticus. Aromatic Syrup. (Rhub. ℥ijss,

Cloves, cinnamon, āā ℥ss; Nutmeg, ʒij; Syrup, Ovj; Dil. alcohol, Oj.)—Elegant remedy in infantile bowel complaints, combined with alkali in cases of green stools.—Dose, fʒj–f℥ss.

Fig. 264.

RHEUM PALMATUM.

Vinum Rhei. Wine. (R. ℥iij; Canella ℥j; Sherry Oj.)—Dose, fʒj–℥ss.

Extractum Rhei. Extract.—Dose, gr. v–xx, in pill.

Pilulæ Rhei. Rhubarb Pills (3 grs. in pill).

Pilulæ Rhei Compositæ. Compound Rhubarb Pills (Rh. ℥j; Myrrh ℥ss; Aloes ʒvj; Peppermint oil fʒss, in 240 pills), an excellent purgative or laxative.—Dose, 2–3 pills.

Pulvis Rhei Compositus. Compound Powder. (Rh. ℥iv; Magnesia ℥xij; Ginger ℥ij.)—Dose, ʒj–ij.

Extractum Rhei Fluidum. Fluid Extract.—Dose, fʒss–j.

Senna.

Leaflets of various species of Cassia. Several commercial varieties. *Alexandria Senna.* Leaflets of C. acutifolia and C. obovata, entire, not longer than an inch. *Tripoli Senna*, distinguished by being very much broken up; from C. Ethiopica. *India Senna*, afforded by C. elongata; length 1–2 inches. *Mecca* and *Tinnivelly* senna are varieties of this. All true senna leaves are distinguished by their oblique lower edges and the inequality of their insertion upon the footstalk; odor faint, peculiar; taste sweetish, nauseous. Active principle, *cathartin*, a resin. Yield to water and alcohol.

Therapeutics.—A very active hydragogue, acting on the whole of the alimentary canal; apt to gripe.

Black Draught, infusion of senna and Epsom salts, ℥ss–j.

Infusum Sennæ. Infusion (S. ℥j; Coriander ʒj–Oj).—Dose, f℥ij.

Confectio Sennæ. Confection. Lenitive Electuary, and laxative.—Dose, fʒj–ij.

Extractum Sennæ Fluidum. Fluid Extract.—Dose, fʒj–ij.

Cassia Marilandica. *American Senna.*

Leaflets of C. marilandica, an indigenous plant. Medical properties similar to those of true Senna, for which they may be substituted in one-third larger dose.

Juglans. *Butternut.*

The inner bark of the root of Juglans cinerea, an indigenous tree.

Extractum Juglandis. *Extract.*—A mild but thorough cathartic. Dose, gr. x–xx, in pill.

Aloes.

The inspissated juice of various species of aloes, prepared either by boiling the leaves in water, or a better variety by expressing the juice, or best by allowing it to drain from the cut leaves.

The U. S. P. recognizes three varieties.

Aloe Socotrina. *Socotrine Aloes.*—Color yellowish or reddish-brown; fracture vitreous, conchoidal, with translucent, garnety edges; powder golden-yellow; odor aromatic; taste bitter, aromatic. The most valuable variety; comes from the island of Socotra in the Red Sea.

Aloe Capensis. *Cape Aloes.*—From A. spicata, which grows in the Cape of Good Hope; color dark olive, or greenish-black; fracture as in last; edges not so strongly garnety; powder greenish-yellow; odor and taste not so aromatic as last.

Aloe Barbadensis. *Barbadoes Aloes.*—From A. vulgaris, growing in the West Indies; color dark brown, not shining; edges perfectly opaque; powder very dull yellow; odor and taste nauseous; the poorest variety.

The active principle of aloes is *aloin* or *aloesin*, a *resin*.

Therapeutics.—A warm cathartic and stomachic, acting on the rectum and lower bowel chiefly, and also as a stimulant to the contiguous pelvic viscera; will sometimes produce piles, if its use be too long continued; chiefly given in constipation, in combination with other purgatives, especially when there also exists atonic amenorrhœa. Dose, as a laxative, gr. ij–v; as a purgative, gr. x–xv.

Fig. 265.

VARIOUS SPECIES OF ALOES.

Tinctura Aloes. *Tincture* (℥j–Oij), f℈j–f℥ss.

Tinctura Aloes et Myrrhæ. *Tincture.* *Elixir Proprietatis* (āā ℥iij–Oij).—Used in amenorrhœa. Dose, f℈j–f℥ss.

Vinum Aloes. *Wine* (Al. ℥j; Cardamom, Ginger, āā ʒj–Oj.)—Dose, fʒj–f℥ss.

Pilulæ Aloes. *Pills*, 2 grs. in 1 pill.

Pilulæ Aloes et Assafœtidæ (āā 1⅓ gr. in pill).—Used as laxative in hysteria, etc.

Pilulæ Aloes et Myrrhæ (A. gr. 2, M. gr. 1 in pill).

Pilulæ Aloes et Mastiches (A. 1⅓ gr.; Mastic, Red Rose, āā gr. ⅓, in pill).

Aloe Purificata. *Purified Aloes.*—Obtained by dissolving in stronger alcohol, straining, and evaporating. Dose, gr. viij–xvj.

Jalapa. *Jalap.*

The root of Exogonium purga, a Mexican morning glory. A tuber-like root, varying in size from that of a walnut to that of an orange; heavy, hard; externally blackish-gray; internally brownish; odor, peculiar, disagreeable, acrid; taste, mawkish, persistently acrid; powder, yellowish-brown. Active principle, *Jalapin*, a resin; also contains largely of starch.

Therapeutics.—A powerful hydragogue cathartic; formerly much used in dropsies, combined with cream of tartar, and in bilious complaints, with calomel. Dose, gr. x–xv.

Resina Jalapæ. *Resin.*—Soluble in alcohol, insoluble in water and ether; very apt to gripe. Dose, gr. j–iij.

Tinctura Jalapæ. *Tincture.* (℥iij–Oj.)—Dose, fʒj–ij.

Extractum Jalapæ. *Extract.*—Enters into comp. cathartic pill. Dose, gr. x–xv.

Pulvis Jalapæ Compositus. *Compound Powder.* (J. ℥j, cream of tartar ℥ij.)—Dose, ʒss–ʒj.

Podophyllum. *May Apple.*

Rhizoma of the indigenous Podophyllum peltatum. In cylindrical pieces, about the size of a very large quill, brownish externally; starchy internally; odor disagreeable; taste acrid, powder resembles jalap, but acts more decidedly on the liver. Active principle, *Podophyllin*, a resin.

Therapeutics.—An active hydragogue and cholagogue.

Extractum Podophylli. *Extract.*—Dose, gr. v–x.

Resina Podophylli. *Resin.*—Much used as an adjuvant or substitute for calomel. Dose, gr. $\frac{1}{8}$–$\frac{1}{4}$, but in combination; else apt to gripe.

Colocynthis. *Colocynth.*

Fruit (a sort of gourd) of Citrullus colocynthis, a vine resembling the cucumber, growing in Southern Europe and in Asia and Africa; about the size and shape of an orange, with a hard, yellowish rind, and a dry, spongy pulp containing the seeds; often divested of its rind; taste excessively bitter; yields to water and alcohol. Contains a bitter principle, *colocynthin*, extractive, resins, etc. A hot infusion gelatinizes on cooling, owing to the amount of pectin in it.

Therapeutics.—A powerful hydragogue; used only in combination. Dose, gr. v–x.

Fig. 266.

PODOPHYLLUM PELTATUM.

Extractum Colocynthidis. Extract.—Dose, gr. ij–v.

Extractum Colocynthidis Compositus. Compound Extract. (Alcoh. extr. Colocynth ℥iijss; Soc. aloes ℥xij; Resin of scammony ℥iij; Cardamom ℥jss; Soap ℥iij.)—Much used as laxative and cathartic. Dose, gr. x–xv.

Gambogia. *Gamboge.*

The concrete juice of the Hebradendron cambogiodes, a tree of Ceylon. Obtained by breaking off shoots and leaves, and allowing juice to concrete gradually in bamboos; thus obtained it is *pipe gamboge*, which occurs in hollow cylinders; gamboge also occurs in irregular masses. Color, reddish; fracture, resinous; odor, none; taste, slight; a gum-resin. Yields to alcohol; makes emulsion with water.

Therapeutics.—A drastic; in overdoses an intestinal irritant, dangerous; never used alone. Dose, gr. ij–iv.

Pilulæ Catharticæ Compositæ. Compound Cathartic Pills.—Comp. extr. of Colocynth ℥ss; extr. of Jalap, Calomel, āā ʒiij; Gamboge gr. xlv—180 pills. The calomel is decomposed by the alkali of the soap, in comp. extr. jalap, so that mercury exists as black oxide. An excellent thorough purgative. Dose, 1–3 pills.

Elaterium.

Product of Momordica elaterium, or squirting cucumber, of Southern Europe. Fruit about the size of a lime, oval, greenish, covered with prickles. Contains an elastic sac, which, when the ripe fruit falls off the vine, bursts the latter open at its stalk end and violently projects its contents. The best elaterium (*Clutterbuck's*) is a substance deposited by juice of sac of unripe fruit. The

Fig. 267.

Helleborus Niger.

ordinary variety is obtained by slicing the fruit and allowing the juice slowly to drain away through a muslin sieve, when the elaterium is deposited on the muslin. A very poor variety is obtained by expression and evaporation. Occurs in flat, thin pieces; grayish-green, with marks of the threads of the cloth on the surface; light and friable; odor, none; taste, bitter, acrid, nauseous. Active principle, *Elaterin*, a crystallizable, neutral principle.

Therapeutics.—A very active hydragogue, with some action on the kidney; used in dropsies. Dose, gr. $\frac{1}{12}$–$\frac{1}{8}$.

Helleborus. *Black Hellebore.*

The root of the Helleborus niger, growing in the mountainous countries of Europe. Yields to water and alcohol.

Therapeutics.—A drastic cathartic, and stimulant emmenagogue; much used by the ancients in mania; rarely given now.

Extractum Hellebori. Extract.—Dose, gr. iij–v.

Tinctura Hellebori. Tincture. (℥iv–Oij.)—Dose, gtt. x–f ʒss.

Oleum Tiglii. *Croton Oil.*

The fixed oil of the seed of the Croton tiglium, of India. The seeds are three, in a three-celled capsule; size of coffee-grains, an external blackish husk around whitish kernel. Oil procured by expressing the warmed seeds. Oil at first nearly colorless, becoming reddish by age; odor slight, peculiar; taste, burning, acrid; composition, complex; the active principle not well made out, not *crotonic acid.* Alcohol dissolves out about 6 *per cent.* only, leaving a bland fixed oil; apt to be adulterated with castor oil, which is however *soluble in alcohol.*

Therapeutics.—Internally, excessively active drastic cathartic, in overdoses very dangerous; externally a powerful irritant, producing a peculiar pustular eruption; internally, used in obstinate constipation, especially from disease of the brain, and as a revulsive in those affections; externally as a revulsive in chronic disease of the lungs. Its application must be made with caution; olive oil is the best diluent. Dose, gtt. j–ij, in pill with crumb of bread, or, if the patient be insensible, simply dropped on the tongue.

MINERAL CATHARTICS.

Sulphur Sublimatum. *Sulphur.*

Flowers of Sulphur. A yellowish powder obtained by sublimating roll sulphur. Always contains some sulphuric acid, rendering it unfit for internal use, which may be removed by washing, as in *sulphur lotum*, U. S. P. (*washed sulphur*).

Therapeutics.—A mild, slowly-acting laxative and alterative, with strong tendency towards the skin, and some towards the bronchial mucous membrane. Used in constipation with hemorrhoids, and as an alterative in chronic rheumatism, catarrh, skin affections, etc. Is absorbed and given off by the skin, etc. Dose, laxative, ʒj–ij in syrup or molasses; as an alterative, gr. x–xx t. d. Used as a local remedy (*unguentum sulphuris* ℥j–℥ij) to kill the itch acarus, also as an alterative and stimulant to the skin in the vapor bath.

Sulphur Præcipitatum. Precipitated Sulphur.—Made by boiling together sulphur and lime, and then adding muriatic acid, which precipitates sulphur. In friable lumps or soft powder of yellowish green-white color, *wholly volatilizable* by heat; if too white, contains *non-volatile* sulphate of calcium. Properties, those of washed sulphur.

Sulphuris Iodidum. Iodide of Sulphur.—Made by heating together iodine and sublimed sulphur. A solid, in grayish-black masses, with a radiating crystalline structure, entirely volatilizable.

Therapeutics.—Used almost solely as a local stimulant and alterative in chronic skin diseases unattended with inflammation, as lepra, porrigo, and the dry stage of eczema.

Unguentum Sulphuris Iodidi. Ointment (℥ss–℥j lard).

Magnesii Carbonas. *Carbonate of Magnesium.*

Obtained by decomposing a solution of the sulphate of magnesium by carbonate of sodium; white, tasteless, inodorous, almost insoluble; in cakes or powder. Two varieties, heavy and light; the density depends upon the strength of the precipitated solution.

Magnesia.

Obtained by driving off the carbonic acid by heat. Often known as calcined magnesia. Two varieties—the *heavy* (*Henry's*, *Husband's*, etc.) and the *light;* the product depending upon the variety of the carbonate used. A white, inodorous, insoluble powder.

Therapeutics.—Magnesia and its carbonate are antacid and laxative. Their cathartic action is somewhat uncertain, being in a measure dependent upon the amount of acid in the alimentary canal. When used as habitual laxatives they are liable to accumulate in the alimentary canal. The carbonate may cause inconvenient distension by the carbonic acid gas which it liberates in the bowels. Used to correct acidity of the stomach and bowels in sick headache, etc. Dose, ʒj–ʒij in syrup or water; often combined with Epsom salts.

Calomel.—Used as a cholagogue. (See ALTERATIVES.)

SALINE CATHARTICS.

These are all powerful hydragogues, causing a great increase of the secretion of the mucous membrane of the bowels and its glands. They are also refrigerant, and are especially adapted to cases in which the indication is to deplete, as in inflammatory affections. Among the vegetable cathartics, senna most resembles them, and is frequently combined with the more powerful of them. They are especially useful in sthenic dysenteric affections, to unload the congested vessels. The watery exudation caused by them renders them especially useful in protracted constipation.

Liquor Potassii Citratis. *Solution of the Citrate.*

Made by adding citric acid (℥ss) to bicarbonate of potassium (ʒvss) in water, Oss, in a strong bottle, and corking immediately. A very agreeable saline, sparkling with the carbonic acid; a little apt to gripe. Dose, Oss.

Magnesii Sulphas. *Epsom Salts.*

Procured by adding sulphuric acid to magnesian limestone, and dissolving out with water; or, better, by acting with the acid on *magnesite*, a native hydrate of magnesia; also from *bittern* of sea water. Occurs in small acicular crystals resembling acetate of lead; very bitter and soluble; slowly efflorescent; contains about 10 per cent. of water of crystallization. A very powerful saline; much used in inflammatory affections. Dose, ℥ss–℥j in water.

Sodii Sulphas. *Sulphate of Sodium. Glauber Salts.*

Procured as residuum after the manufacture of muriatic acid, also from bittern of sea water. Occurs in four-sided efflorescing crystals, containing more than 50 per cent. of water of crystallization; more soluble in water at 90° F. than at 212° F. Taste, very nauseous, bitter; rarely used. Dose and therapeutics about the same as of Epsom salts.

Potassii Sulphas. *Sulphate of Potassium. Vitriolated Tartar.*

Obtained as result of action of sulphuric acid on nitre in manufacture of nitric acid. Small, white, very hard, prismatic crystals; not very soluble. A mild saline, rarely used save in Dover's powders.

Potassii Tartras. *Tartrate of Potassium. Soluble Tartar.*

Made by saturating a solution of the bitartrate of potassium with the bicarbonate; crystallizes in deliquescent, soluble, irregular, six-sided prisms; often occurs in white, granular powder; taste, bitterish, saline. A mild cooling saline; rarely used. Dose, ℥ss–j.

Potassii Bitartras.

Obtained by purifying the *argol* or *crude tartar* deposited in wine casks during the fermentation, and incrusting the inside with reddish cakes if from red wine, dirty-white if from white wine. Occurs in white crystalline crusts; generally kept in the shops in form of a white, gritty powder. Taste, acid, saline; soluble in sixty parts of cold water, fifteen of boiling.

Therapeutics.—In a large, single dose a mild refrigerant saline; more used, however, as a refrigerant diuretic, for which purpose ℥j should be dissolved in a pint of juniper-berry infusion, and drunk in the course of twenty-four hours. Dose, as purgative, ℥j–ij; often combined with jalap, or with sulphur.

Sodii et Potassii Tartras. *Tartrate of Potassium and Sodium. Rochelle Salt.*

Made by saturating a solution of the bitartrate of potassium with the carbonate of sodium. In large pyramidal, efflorescent, very soluble, truncated crystals, of saline, not very disagreeable taste.

Therapeutics.—An excellent mild saline. Dose, ℥ss–℥jss.

Pulveres Effervescentes Aperientes. Seidlitz Powders.—Rochelle salt, ʒij, Bicarbonate of sodium, gr. xl, in blue paper; Tartaric

acid, gr. xxxv, in white paper; to be dissolved separately and then added to each other, and swallowed during effervescence. The tartrate of sodium is formed, and carbonic acid set free. An excellent, mild, agreeable saline. Dose, 1–2 powders.

Sodii Phosphas. *Phosphate of Sodium.*

Prepared by decomposing the phosphate of calcium of bones by sulphuric acid and water, the insoluble sulphate being precipitated and the superphosphate left in solution; then pouring off the supernatant liquid and adding carbonate of sodium, when phosphate of sodium remains in solution, and carbonate of calcium is precipitated. Occurs in large rhombic, efflorescent crystals, about 75 per cent. water of crystallization; taste, resembling common salt.

Therapeutics.—A mild saline. Used for children on account of its taste. May be given in broth or soup. Dose, ℥j.

CHAPTER XV.

DIURETICS.

THESE are medicines which increase the secretion of urine. There is in one sense an antagonism between the skin and the kidneys, so that when the former is active the latter are passive, and *vice versa.* Hence external circumstances that favor the action of the skin, lessen that of the kidneys, and *vice versa;* especially is this true in regard to medicines that are at once diuretic and diaphoretic. Therefore exposure to a cool temperature favors a diuretic action, warmth and perspiration lessen it. The function of the kidneys is also affected by the state of the bowels. When the water of the blood is drained off by a profuse watery discharge from them, it is manifest that the supply of water to the kidneys is checked. The action of diuretics is moreover much modified by functional or organic disease of the kidney. In most dropsies there is either a structural change, or intense passive congestion of the kidneys (as in heart and liver dropsies); therefore it is, that diuretics so frequently fail us in those complaints. All true diuretics act by being absorbed, carried into the kidney, and there stimulating the secreting cells. Very many of them act apparently as alteratives, though they are simply tonic eliminatives, causing the morbid matters in the blood to be excreted by the kidneys. They are used to promote and keep up the action of the kidneys, as in various fevers; to evacuate fluid, as in dropsies; to cause the elimination of retained secretions or other *materies morbi*, as in rheumatism; to alter the urinary secretion, as in gravel; to act locally on the urino-genital apparatus, either soothingly or as local stimulants. Some of them seem to stimulate and in large dose irritate the kidneys, especially when inflamed; others, while promoting secretion, seem to soothe and quiet irritation; hence the two classes, *stimulant* and *sedative diuretics.*

STIMULANT DIURETICS.

Scilla. *Squills.*

The bulb of the *Scilla maritima*, a lily of the Mediterranean shores. Roundish, size from a man's fist to a child's head, composed of wrappings one over the other like an onion; when sliced across, these fall apart in the form of flake-like, horny pieces, in which shape squills occur in the shops. There are two varieties; *red* and *white;* no important differences. Taste bitter, acrid, nauseous. Yields best to vinegar, well to alcohol; active principle, *scillitin.*

Therapeutics.—In small doses a stimulant diuretic and expectorant; in large doses a harsh emetic. As a diuretic, used in dropsies, especially in combination with digitalis. As an expectorant, used in latter stages of acute bronchitis and pneumonia, especially when there is any typhoid tendency. As a diuretic generally given in substance, in pill. Dose, gr. ss. As an expectorant, given in one of its preparations.

Tinctura Scillæ. *Tincture* (℥ij–Oj).—Dose, as expectorant, gtt. x–xxx.

Acetum Scillæ. *Vinegar* (℥ij–Oj).—Dose, gtt. x–xxx.

Syrupus Scillæ. *Syrup.* (Vinegar of Squill, Oj; Sugar, ℥xxiv.) —Incompatible with carbonate of ammonium. Dose, f℥ss–iss.

Pilulæ Scillæ Compositæ. *Compound Pills.* (Squill gr. ss; Ginger, Ammonia, āā gr. j; Soap gr. iss, in a pill.)—Used in chronic bronchitis. Dose, 1–2 pills.

Fig. 268.

COLCHICUM AUTUMNALE.

Colchici Radix. *Colchicum Root.* **Colchici Semen.** *Colchicum Seed.*

The corm and seed of Colchicum autumnale, or meadow saffron of England. Corm about the size of a chestnut, covered with a brownish membrane; internally solid, white, fleshy, with a groove running along one side of it. Often kept in shops in transverse slices, each of which should have a notch in one side. Taste bitter, acrid; odor scarcely perceptible. It should be gathered in the latter part of July or in August. Seeds small, blackish externally, whitish within, resemble black mustard seed; taste bitter, acrid; less apt than the

bulb to spoil by keeping. Both contain *colchicia*, an alkaloid related to but not identical with veratria.

Therapeutics.—Stimulant to most of the secretions; acts on the kidneys, especially as an eliminative, and is chiefly useful in *gout*, in which saline cathartics may be used as its adjuvants. It exercises a sedative influence on the circulation, lessening the frequency and force of the pulse. In large doses, a cathartic; in overdoses, a powerful intestinal irritant, with a marked influence on the nervous system.

Scudamore's Mixture.—Consists of a draught containing 15–20 grs. magnesia, ʒj–ij Epsom salt, wine of colchicum root, fʒss j.

Acetum Colchici. Vinegar. Not now officinal.

Vinum Colchici Radicis. Wine of C. Root (℥vj–Oj).—Dose, gtt. x–xxx.

Vinum Colchici Seminis. Wine of C. Seed (℥ij–Oj).—Dose, gtt. x–fʒss.

Extractum Colchici Aceticum. Acetic Extract.—Made from root. Dose, gr. j–ij t. d.

Fluid Extracts of the root and seed are also officinal. Dose, gtt. v–x.

Terebinthina. *Turpentine.*

The juice of Pinus palustris and other species inhabiting the southern United States. Collected by cutting, in the spring of the year, deep notches into the tree, of such a shape that the turpentine gradually drains into them, and is afterwards ladled out into barrels. On exposure, the juice hardens into *white turpentine;* yellowish-white, irregular masses, of peculiar odor and hot taste. Consists of resin with 17–25 per cent. of volatile oil.

Terebinthina Canadensis. *Canada Turpentine.*

The juice of the Abies balsamea, or balm of Gilead, growing in Canada and the most northern United States. Transparent, yellow, thick liquid; odor and taste resembling the above. The turpentines are very inflammable hydrocarbons, insoluble in water, soluble in alcohol. They are oleoresins, the resin being produced by the oxidization of the volatile oil. They are used externally as local stimulants; for internal exhibition their volatile oils are preferred. *Oil of turpentine* has already been treated of; as a diuretic it is only used for its local stimulant effect upon the urino-genital mucous membrane. Canada balsam is sometimes given in chronic bronchitis and chronic rheumatism. Dose, ʒss.

Resina. Resin.—The residue of the distillation of white turpentine. Used externally as a stimulant.

Ceratum Resinæ. Resin Cerate. Basilicon Ointment. (Resin, ℥x; Yellow wax, ℥iv; Lard, ℥xvj.)—Used as a stimulant to ulcers, or to keep blisters open.

Ceratum Resinæ Compositum. Compound Resin Cerate. (Resin, Suet, Yellow wax, āā ℥xij; Turpentine, ℥vj; Flaxseed oil, ℥vj.)—Similar to but more stimulant than the last.

Emplastrum Resinæ. Resin, Adhesive, or Sticking Plaster. (Resin, ℥vj; Lead plaster, ℥xxxvj.)—Used in surgery.

Pix Liquida. *Tar.*

The product of the destructive distillation by slow combustion of the wood of Pinus palustris; composition excessively complex; contains creasote, various empyreumatic oils, resins, etc.; slightly soluble in water, freely in alcohol. Used as a stimulant to the bronchial mucous membrane, either by inhalation of vapor or as *Infusum Picis Liquidæ. Tar Water.*—Dose, f℥ij. Externally used as a stimulant in skin diseases.

Unguentum Picis Liquidæ. Tar Ointment. (Tar, Suet, āā ℥xij.)

Copaiba.

The juice of Copaifera officinalis and other species; leguminous plants of Brazil. Procured by making incisions. At first clear and rather thin, becoming thicker and yellowish-red by age; odor peculiar, strong; taste hot, peculiar; insoluble in water, soluble in alcohol; virtues depend upon the volatile oil, which by exposure oxidizes into a resinous acid, *copaivic;* proportion of oil varies from 30 to 60 per cent. Solidifies with magnesia—not a balsam.

Therapeutics.—A stimulant diuretic; in overdoses causing nausea and vomiting; a stimulant alterative to the mucous membranes generally, but especially to the urino-genital. Used chiefly in gonorrhœa before or after the acute inflammatory symptoms, also in chronic bronchitis, and chronic dysentery. Dose, gtt. x–f℥ss, t. d.

Oleum Copaibæ. Oil of Copaiba.—The volatile oil obtained by distillation. Dose, gtt. v–x, in emulsion, or better, in gelatin capsules.

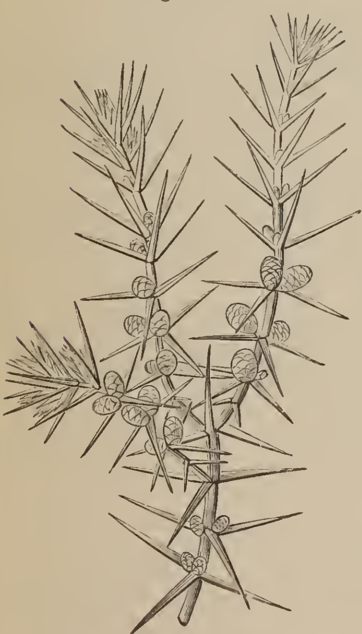
Pilulæ Copaibæ. Pills. (Copaiba, ℥ij; Magnesia, ʒj —200 pills.) Dose, iij–v pills.

Cantharides. (See *Epispastics.*)

Juniperus. *Juniper Berries.*

Fruit of the Juniperus communis, or common juniper; globular, about the size of a large pea; dark purple, glaucous; taste sweetish, warm, terebinthinate; odor aromatic. Active principle, a volatile oil. Yields to hot water and alcohol. Used as

Fig. 269.



JUNIPERUS COMMUNIS.—Branch with male flower.

a slightly stimulant diuretic, and stomachic, mostly as an adjuvant to cream of tartar.

Infusum Juniperi. Infusion. (℥j–Oj.)—Dose, Oj in twenty-four hours.

Oleum Juniperi. Oil of Juniper.—Dose, gtt. x–xx.

Spiritus Juniperi Compositus. Compound Spirit. (Oils: Juniper, f℥jss; Caraway, Fennel, āā ♏x; Dil. alcohol, Oviij).—Resembles gin. Dose, f℥j–f℥ss.

Taraxacum. *Dandelion.*

Root of the Leontodon taraxacum, or common dandelion. Root spindle-shaped, brownish, several inches long, bitterish; in fresh state abounding with a milky juice.

Therapeutics.—Tonic, diuretic, said to act on the liver; used in dyspepsia with habitual torpor of the liver; must be used generally for a long time before effects are to be looked for.

Infusum Taraxaci. Infusion. (℥ij–Oj boiling water.)—Dose, f℥ij–iij t. d.

Extractum Taraxaci. Extract.—An inspissated juice. Dose, gr. xx–xxx t. d.

Extractum Taraxaci Fluidum. Fluid Extract.—Dose, f℥ss–ij t. d.

Succus Taraxaci. Juice.—Dose, f℥ss–j.

Buchu. *Buchu.*

The leaves of Barosma crenata, of the Cape of Good Hope. Small, ovate, crenulate leaves; aromatic odor, warm, bitterish, peculiar taste; contains volatile oil, and bitter extractive. Yields to water and alcohol.

Therapeutics.—A slightly stimulating diuretic; used only for its local stimulant action on the urino-genital mucous membrane; given in chronic cystitis, irritable bladder, etc.

Infusum Buchu. Infusion. (℥j–Oj boiling water.)—Dose, f℥j–ij.

Extractum Buchu Fluidum. Fluid Extract.—Dose, f℥j.

Pareira.

The root of the Pareira brava of South America; comes in very long, woody pieces, one-half to three inches in diameter, with a brownish, closely adherent bark; a taste at first sweetish, then bitterish and nauseous. Contains alkaloid *cissampelina*, extractive, etc. Yields to water and alcohol.

Therapeutics.—Similar to the last.

Infusum Pareiræ. Infusion. (℥j–Oj boiling water.)—Dose, f℥j–ij.

Erigeron. *Fleabane.*

Herbaceous plants of the indigenous composites, Erigeron Philadelphicum and heterophyllum. Contain a volatile oil.

Therapeutics.—Gently diuretic; used in chronic functional kidney affections. The oil is a valuable hemostatic, especially useful in menorrhagia.

Carota. *Wild Carrot.*

The seeds of the Daucus carota, an indigenous umbellifer. Active ingredient, a volatile oil.

Therapeutics.—A mild stimulating diuretic, somewhat stomachic. Given in infusion (f℥ss–Oj). Used as adjuvant.

Apocynum Cannabinum. *Indian Hemp.*

The root of the Apocynum cannabinum, an indigenous plant. Contains an acrid oleoresin. An active diuretic; in overdoses an irritant emeto-cathartic. Given in decoction (℥ss–Oj). Dose, f℥j–ij t. d.

Petroselinum. *Parsley Root.*

Has diuretic properties. Diuretic principle, a volatile oil. Contains *apiol*, a yellowish, oily, non-volatile liquid; odor peculiar, distinct from that of the plant; taste, acrid pungent; affects the system somewhat like quinine; used as antiperiodic. Dose, gr. xv, in gelatin capsules.

Potassii Carbonas. *Carbonate of Potassium.*

Pearl ash (Potassii Carbonas Impura, U. S.), or impure carbonate of potash, is obtained from wood ashes. When this is purified by repeated solutions in water, filtering, and evaporation, it constitutes the officinal drug; generally contains some silicate; crystallizes with difficulty; occurs generally in small granules; soluble in water, insoluble in alcohol; decomposed by acids, with liberation of carbonic acid; deliquescent.

Therapeutics.—Antacid, alkaline, and diuretic. It renders the urine alkaline, and hence is used when it is desirable to modify that secretion, as in gravel. When the alkaline remedies are taken for too long a period, they are apt to cause spanæmia (anæmia). Dose, gr. x–ʒj.

Potassii Carbonas Pura. *Pure Carbonate of Potassium.*

Made by heating the bicarbonate; preferable to the last on account of its purity.

Potassii Bicarbonas. *Bicarbonate of Potassium.*

Made by passing carbonic acid through a solution of the carbonate. Occurs in irregular, eight-sided, very deliquescent prismatic crystals; soluble in four times its weight of water; medical uses same as the last. Dose, gr. x–ʒj.

Cream of Tartar. See *Cathartics.*

Potassii Acetas. *Acetate of Potassium.*

Made by action of dilute acetic acid on the bicarbonate; occurs in soft, fibrous masses; very deliquescent; soluble in half its weight of water, twice its weight of alcohol; taste saline.

Therapeutics.—Alkaline, powerfully diuretic, slightly purgative. Used very largely in acute inflammatory rheumatism, in which ʒj

should be exhibited in the twenty-four hours. Dose, ʒj–ij, in water.

Saltpetre. See *Diaphoretics.*

Spiritus Etheris Nitrosi. *Spirit of Nitrous Ether. Sweet Spirits of Nitre.*

Made by action of nitric acid on alcohol; one proportion of the acid, acting on the alcohol, forms aldehyde, nitrous acid, and water. The nitrous acid then reacts upon more of the alcohol; to form nitrite of ether and water. Chemically a mixture of nitrite of ether and alcohol. A limpid fluid, sp. gr. 0.837; taste warm, sweetish; odor peculiar, ethereal; boils at 145° F.; becomes strongly acid and unfit for use by age; soluble in alcohol and water.

Therapeutics.—An elegant, slightly stimulant diuretic, diaphoretic, and antispasmodic; much used in low fevers and febrile affections of children with nervous irritability. Dose, fʒj, in water.

CHAPTER XVI.

DIAPHORETICS.

These are medicines which produce perspiration. They produce their effects by: (1), relaxing the surface; (2), stimulating the cutaneous circulation; (3), acting directly on the cutaneous glands; (4), sympathy from the stomach; (5), filling the blood-vessels. They are used (1), to promote the subsidence of diseases which usually end in a sweat; (2), to deplete; (3), to produce revulsion by determination to the surface; (4), to promote absorption; (5), to eliminate. They are often uncertain in their action. They are divided into Nauseating, Refrigerant, and Alterative Diaphoretics.

NAUSEATING DIAPHORETICS.

Pulvis Ipecacuanhæ Compositus. Dover's Powder. (See *Opium.*) —Very useful in rheumatism, diarrhœa, dysentery, latter stages of bronchitis, and pneumonia.

Antimonii et Potassii Tartras. Tartar Emetic. (See *Emetics.*) —Used in inflammatory cases.

REFRIGERANT DIAPHORETICS.

Potassii Citras. *Citrate of Potassium.*

Made by decomposing the bicarbonate of potassa with citric acid. A white, granular, very deliquescent and soluble salt.

Therapeutics.—A slightly sedative diaphoretic, used in fevers. Dose, gr. v–xx.

Liq. Potassii Citratis. Solution of the Citrate of Potassium.—Made by saturating a solution of the bicarbonate of potassium with citric acid.

Mistura Potassii Citratis. Mixture of the Citrate of Potassium. Neutral Mixture.—Made by saturating lemon juice with the bicarbonate. Essentially the same as the last, but more pleasant to the taste. Dose, f℥ss every two or three hours. The effervescing draught is the same given whilst effervescing: ʒiij of the bicarbonate in f℥iv of water; lemon juice and water, āā f℥j; a tablespoonful of the former to be added to two tablespoonfuls of the latter; to be taken foaming. When lemon juice is not procurable, a solution of citric acid (℥j–Oj) containing a modicum of the oil of lemon may be substituted. Used to allay vomiting, and to favor diaphoresis in fevers.

Liquor Ammonii Acetatis. *Solution of the Acetate of Ammonium. Spirit of Mindererus.*

Made by adding carbonate of ammonium to dilute acetic acid. A colorless, limpid liquid, of a bitterish, cooling taste, closely resembling, in its medical properties, the neutral mixture. Dose, f℥ss every hour or two.

Potassii Nitras. *Nitrate of Potassium.*

Synonyms, nitre, saltpetre.—For medicinal use, this is purified from the nitrate of potash of commerce. It appears in white masses, or colorless, opaque hexagonal prismatic crystals. Taste peculiar, cooling. It deflagrates when heated. With sulphuric acid and copper filings it gives off reddish fumes.

Therapeutics.—Nitrate of potassium is a very valuable refrigerant diaphoretic, especially in *croup*, *bronchitis*, *pneumonia*, and *pleurisy*. In *gout*, it is serviceable also as an alkaline *anti-lithic* agent; being often prescribed with Rochelle salt or the bicarbonate of potassium. Dose, gr. x–xxx, in powder or solution.

Guaiaci Lignum. *Guaiac Wood.* **Guaiaci Resina.** *Guaiac Resin.*

The product of the Guaiacum officinale, or *lignum vitæ* tree, of the West Indies; wood heavy. The *core* or *heart wood* is alone used; it is very heavy, dense, hard; very dark, brownish or greenish; often variegated; when rubbed or burned, gives off the odor of the resin; taste, bitterish, peculiar, at last pungent. The *resin* is obtained by boiling raspings and chips of the wood in water, or by burning very slowly one end of billets, which have been bored longitudinally, and catching the melted resin as it runs out of the other end away from the fire. Color deep olive, greenish-brown; odor peculiar, balsamic, much increased by heat. The pure resin has received the name of *guaiacin* or *guaiacic acid;* soluble in alcohol, slightly so in water. Nitric acid produces a blue color.

Therapeutics.—A stimulant, alterative diaphoretic. Used in chronic rheumatism, chronic skin diseases, etc.; also in emmenagogue mixtures.

Tinctura Guaiaci. Tincture. (℥vj–Oij.)—Dose, fʒss–j.

Tinctura Guaiaci Ammoniata. Ammoniated Tincture. (℥vj, aroma. sp. ammonia Oij.)—Dose, f℥j.

Mezereum. *Mezereon.*

The bark of the Daphne mezereum and other species, growing in Europe. That of the root is preferable; but it is obtained from the trunk and branches also. Occurs in long strips, generally folded into bundles, and wrapped together by other strips; externally with a grayish epidermis, internally whitish; tough and pliant. Taste at first sweetish, then very acrid. Yields to boiling water. Active principle, an *acrid resin;* not *daphnin.*

Therapeutics.—Externally applied, it is a strong irritant, and even vesicant; hence is sometimes used to keep blisters, issues, etc., sore. Internally a stimulant, alterative, diaphoretic, and diuretic; used only in combination, as in compound decoction of sarsaparilla.

Sassafras Radicis Cortex. *Bark of Sassafras Root.*

Bark of the indigenous Sassafras officinale. Occurs in irregular, brittle fragments, of a cinnamon color, and hot aromatic taste; odor aromatic, peculiar. Active principle, a volatile oil.

Therapeutics.—A mild diaphoretic. Used only as a flavoring adjuvant or in stimulating liniments.

Oleum Sassafras. Oil.—Yellowish, becoming reddish by age; odor and taste that of the bark concentrated. Dose, gtt. ij–x.

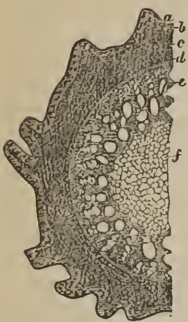
Medulla Sassafras. Sassafras Pith.—Occurs in very light, white cylindrical pieces. It is obtained from the young twigs. Forms with water an elegant, bland, thick mucilage; much used as a local application in ophthalmia, and other acute external inflammations. Should be made ʒj–Oj boiling water.

Sarsaparilla.

Roots of the Smilax officinalis and other species, natives of Mexico and Central America. These are climbing vines, closely allied to and resembling our common green brier. The roots are very long and slender, often furnished with numerous rootlets, several of them arising from a common rootstock. There are several varieties, the most common of which is the *Honduras*, which comes in bundles two or three feet long, formed of a number of roots folded lengthwise and bound together by circular turns; the bundles are packed in bales imperfectly covered with skins. The *Jamaica* sarsaparilla does not differ from the Honduras, except it be that its epidermis is more reddish. It does not grow in Jamaica, but is brought there from Central America, and goes entirely to the European market, *Brazilian* or *Lisbon Sarsaparilla*, the *Sarsa of the Rio Negro*, is said to be the most valuable variety, but is rarely seen in the United States. It occurs in bundles several feet long, bound about by numerous close turns of a flexible stem. The odor of sarsaparilla is scarcely perceptible; the taste is mucilaginous, becoming acrid on chewing. Yields to boiling water and alcohol. Active principle, a neutral crystallizable substance, *Sarsaparillin* (Smilacin), which has, in solution, a bitter, acrid, nauseous taste.

Therapeutics.—An alterative diaphoretic, and tonic. Used in chronic diseases, such as syphilis, scrofula, rheumatism, skin diseases, etc.

Fig. 270.



JAMAICA SARSAPARILLA (SECTION MAGNIFIED).

Fig. 271.

BUNDLE OF JAMAICA SARSAPARILLA.

Decoctum Sarsaparillæ Compositum. *Compound Decoction.* *Lisbon Diet Drink.* (Sars. ℥vj; sassafras root bark, guaiac wood, liquorice root, āā ℥j; mezereon ʒiij; water to make four pints of decoction.)—Dose, f℥ij–v.

Syrupus Sarsaparillæ Compositus. *Compound Syrup.* (Sars. ℥xxiv; guaiac wood ℥iij; red rose, senna, liquorice root, āā ℥ij; ol. sassafras, ol. anise, āā ♏v; ol. gaultheriæ ♏iij; dil. alcohol to make four pints; add sugar ℥xcvj.)—Dose, f℥ss–ij.

Extractum Sarsaparillæ Fluidum. *Fluid Extract.*—Dose, fʒj–ij.

Extractum Sarsaparillæ Compositum Fluidum. *Compound Fluid Extract.* (Contains liquorice root, sassafras root bark, mezereon.)—Dose, fʒj–ij.

The root of the indigenous *Aralia nudicaulis* is officinal in the U. S. secondary list, and is said to possess similar therapeutic properties to sarsaparilla.

CHAPTER XVII.

EXPECTORANTS.

MEDICINES which promote, increase, or modify the bronchial secretions. Substances the most opposite in their action may be used as expectorants; and the choice must be made in accordance with the condition of the lung tissue. Thus, when there is active inflammation, secretion is promoted by relaxant, sedative substances; pre-eminent amongst the latter are *tartar emetic* and *ipecac*, with their preparations. In the advanced stages of disease, when the expectoration is excessive and morbid in quality, the stimulating alterative expectorants are to be employed. There are cases in which there is an abundant secretion, but a want of power in the muscular tissue concerned to cough up the secretion, which therefore accumulates in the bronchi and air cells, and may even

so fill up the lung tissue as to suffocate the patient. who is, as it were, drowned. In such cases the stimulating expectorants are useful, not only by altering the secretions, but by giving the ability to expel them.

STIMULATING EXPECTORANTS.

Scilla. *Squills.* (See EMETICS.)

Senega. *Seneka.*

The root of Polygala senega, an indigenous herbaceous plant. Root consisting of a knotted rootstock giving origin to a number of contorted rootlets, each of which has a projecting keel or raised line shorter than the rootlet, which appears as though the ends were drawn together by a string under the bark. Odor peculiar; taste sweetish, then acrid; color, externallybrownish, internally yellowish; composed of a cortical and inner woody, inert cylinder. Yields to water and alcohol. Active principle of *Polygalic acid.*

Fig. 272.

POLYGALA SENEGA.

Therapeutics. — An active stimulating expectorant, acting in overdoses like squill, as a harsh emetic, and also having some tendency towards the kidneys. Used only in typhoid cases, or in the latter stages of bronchitis and sthenic pneumonia; often combined with carbonate of ammonia; an ingredient in *Cox's Hive Syrup* (Syrupus Scillæ Comp.).

Decoctum Senegæ. Decoction (℥j–Oj).—Dose, f℥ss–j.

Syrupus Senegæ. Syrup.—Dose, f℥ss–ij.

Extractum Senegæ. Extract.—Dose, gr. j–iij.

Ammoniac. *Ammoniac.*

The concrete juice of Dorema ammoniacum, an umbelliferous plant growing in Persia. Occurs in irregularly globular tears, from size of a pin's head to a chestnut; yellowish externally, hard, brittle, with a shining whitish fracture; also in irregular masses, resembling them, but darker, with many impurities; odor faint, peculiar, disagreeable; taste bitterish, acrid, nauseous; softens but does not melt by heat. A gum-resin, containing some volatile oil.

Therapeutics.—Stimulant expectorant, sometimes acting as a

diuretic, diaphoretic, or emmenagogue. Used when there is a too copious secretion, with relaxation and debility.

Mistura Ammoniaci. Ammoniac Mixture (℥ij–Oj). An emulsion made by rubbing up with water.—Dose, f℥ss–j.

Emplastrum Ammoniaci.—Used as a resolvent on tumors and enlarged joint.

Emplastrum Ammoniaci cum Hydrargyro.—Used for similar purposes to the last.

Galbanum.—Resembles the last; rarely used.

Benzoinum. *Benzoin.*

The concrete juice of the Styrax benzoin, a native of Siam. A balsam with the peculiar pungent, aromatic taste and odor of benzoic acid, which may be obtained from it by distillation; rarely used.

Tinctura Benzoini Composita. Compound Tincture.—Dose, f℥ss–j.

Acidum Benzoicum.—As officinal, in minute, shining, white, feathery crystals, containing some volatile oil, to which it owes its odor. When quite pure inodorous; scarcely soluble in cold water; soluble in watery solution of borax and in alcohol; fusible and vaporizable. Chemically a hydrated oxide of benzyl.

Therapeutics.—Stimulating, with a decided diuretic tendency; in large doses apt to oppress the stomach. Dose, gr. x in pill or emulsion.

Ammonii Chloridum. *Chloride of Ammonium.*

Former name, *muriate of ammonia.* Useful in the treatment of *chronic bronchitis.* See *Arterial Stimulants.*

Balsamum Peruvianum. *Balsam of Peru.*

Obtained by making and slightly burning incisions in the bark of the Myrospermum peruiferum, a tree of South America. A thick viscid liquid of a reddish-brown color; odor like that of balsam of Tolu, but not so pleasant; taste warm, bitterish. Chemical composition the same as that of the following, which is probably prepared in a little different way from the same tree.

Therapeutics.—Same as following; often used externally as a local stimulant to ulcers, etc.

Balsamum Tolutanum. *Balsam of Tolu.*

The juice of Myrospermum toluiferum (probably the same as M. peruiferum), obtained by simple incisions. As it first exudes, a thick, viscid liquid; afterwards it concretes into a semi-solid, and finally into a hard, resinous, translucent, reddish solid; odor very fragrant; taste pleasant, somewhat resembling that of vanilla. Contains resin, volatile oil, and cinnamic acid.

Therapeutics.—A stimulant expectorant, much used in cough mixtures on account of its agreeable flavor.

Tinctura Tolutana. Tincture. (℥jss–Oj.)—Dose, f℥ss–j.

Syrupus Tolutanus. Syrup.—Dose, f℥j–f℥ss.

Prunus Virginiana. *Wild Cherry Bark.*

This, often valuable as an expectorant, especially in the form of a syrup, has been described under the head of *Tonics* (*Peculiar Bitters*).

CHAPTER XVIII.

EMMENAGOGUES.

Medicines which promote the menstrual discharge. It has been doubted whether there are any medicines which act specifically on the uterine tissue. Some of them act by *contiguous sympathy*, by powerfully stimulating and congesting neighboring viscera. Such are pre-eminently aloes and cantharides. Amenorrhœa is more generally the sequence and not the cause of disease, and many remedies act by relieving the affections which give rise to menstrual cessation; thus, anæmia is the most frequent cause of amenorrhœa; hence the various *chalybeates* are amongst the most reliable emmenagogues. On the other hand, plethora may cause over-fulness of the uterine vessels with cessation of the menses, and this, evidently, must be met by depletory measures. Most of the important stimulating emmenagogues, such as aloes, cantharides, black hellebore, and guaiac, are elsewhere treated of.

Sabina. *Savin.*

The dried tops of the Juniperus sabina, the European juniper, though cultivated in the United States. They very closely resemble the tops of our common juniper. Odor and taste terebinthinate. Contain a volatile oil.

Therapeutics.—A stimulant to the secretions generally; in overdoses a powerful irritant. In pregnancy it may produce abortion by its powerfully irritant action on the uterus. It is often useful in menorrhagia dependent on uterine atony. Dose, gr. v–xx.

Oleum Sabinæ. Oil.—Yellowish. Dose, gtt. ij–viij.

CHAPTER XIX.

SIALAGOGUES.

Medicines which produce salivary discharges by their local impression. They are now very rarely if ever used. Tobacco, mezereon, and pyrethrum or pellitory (the root of Anacyclus pyrethrum) have been thus employed.

CHAPTER XX.

ERRHINES.

MEDICINES employed to make an impression on the mucous membrane of the nose; when they excite sneezing they are sternutatories. They are very rarely used. Tobacco, ammonia, euphorbium, ipecacuanha, etc., may be employed as errhines.

CHAPTER XXI.

EPISPASTICS.

MEDICINES which, when applied to the skin, cause vesication. Most of the rubefacients, chloroform, and numerous irritants are capable of vesicating, but very rarely is any drug but cantharides used as an epispastic. When a rapid effect is desired, an almost instantaneous blister may be produced by placing some strong water of ammonia on the surface, and covering it with a watch-glass, or oiled silk. The first effect of a blister is of course local; but it may produce a sympathetic fever which shall involve the whole system. The indications for their use are: 1. As evacuants; thus, blisters sometimes aid in the removal of fluid from the peritoneal cavity by the large watery discharge which they occasion. 2. As derivatives; thus they are used as powerful revulsives in the latter stages of inflammation of internal organs; in this way blisters may even act as anodynes, relieving pain. 3. As local stimulants. 4. To substitute their action for a diseased action in a part, as in obstinate herpes. 5. To procure a denuded surface for the endermic application of a medicine. They are contra-indicated by high inflammatory action, especially when the system sympathizes and there is an excited state of the circulation.

Cantharis. *Cantharides.*

The Cantharis vesicatoria, a beetle, from six to ten lines in length, by two or three in breadth, of a bright shining green color. They inhabit the south of Europe, where they are collected during the summer months, by shaking them from the bushes or trees which they frequent, into sheets or large clothes, and then plunging them into hot vinegar and water to kill them; after this they are carefully dried in the sun and put into tin canisters. Odor strong and peculiar; taste acrid, burning; powder greenish, with bright green specks through it; very apt to deteriorate by keeping. Yields to water and alcohol. Active principle, *cantharidin;* crystalline, in-

odorous, tasteless, insoluble in water and cold alcohol, soluble in ether; said to be most abundant in the genitals of the insect.

Fig. 273.

CANTHARIDES.

Therapeutics.—Internally, in small doses, a stimulating diuretic and emmenagogue, causing, in overdoses, bloody urine, painful micturition, priapism, strangury, and also irritation and inflammation of the alimentary mucous membrane. Externally the best epispastic.

Ceratum Cantharidis. Cantharidal Cerate. (C. ℥vij; Yellow wax, Resin, āā ℥vij; Lard, ℥x.)—Blisters are prepared by spreading this cerate on kid, or, better, adhesive plaster, of the required size, a clean wide margin being left. In most positions, from six to eight hours is sufficiently long for the blister to be left on; if vesication has not taken place, it may be facilitated by a warm poultice; on the scalp from ten to sixteen hours may be required; on children, three or four hours generally suffice. If it is desirable rapidly to heal the blister, it should be dressed with simple or with Goulard's cerate; if it is to be kept discharging, basilicon ointment is generally used. If strangury be produced, opium enemata and diluent drinks should be exhibited.

Ceratum Extracti Cantharidis. Cerate of Extract.—Used only as a very powerful irritant to blisters—not as an epispastic.

Linimentum Cantharidis. Liniment. (C. ℥j; Oil of turpentine, Oss.)—A very powerful rubefacient, capable of vesicating and producing severe inflammation of the skin.

Collodium cum Cantharide. Cantharidal Collodion.—Used as a blister; should be applied with a camel's hair brush, two or three coats, and allowed to dry slowly; best under oiled silk.

Emplastrum Picis cum Cantharide. Warming Plaster. (Burgundy pitch, ℥xlviij; canthar. cerate, ℥iv.)—Used as a rubefacient in chronic diseases; it sometimes vesicates.

CHAPTER XXII.

RUBEFACIENTS.

MEDICINES which cause redness, irritation, and inflammation of the skin, when applied to it. They are used as revulsives when a more permanent or diffuse counter-irritation, or a less severe

application than a blister, is desirable; they are especially useful for irritation of an internal organ, as, for instance, applied to the feet and legs in cases of irritation of the brain.

Pix Burgundica. *Burgundy Pitch.*

The product of the Abies excelsa, or Norway spruce, a lofty tree of Northern Europe. Obtained by stripping off the bark, beneath which it concretes, melting the impure resin in boiling water, and straining. In hard, brittle, irregular masses, of a yellowish-brown color, softening at the heat of the skin; odor and taste feeble, somewhat terebinthinate.

Therapeutics.—A gentle rubefacient.

Emplastrum Picis Burgundicæ. Burgundy Pitch.—Made by spreading the melted pitch, melted with yellow wax, on soft skin. Used in various chronic disorders as a persistent counter-irritant.

Pix Canadensis. *Canada Pitch.*

Product of the Abies canadensis or hemlock spruce, a tree of the Northern United States and Canada. Is found adhering to the bark of old trees, from which it is scraped off, melted in boiling water, and strained. Hard, brittle, dark-brownish, with feeble odor, softening at the heat of the body. Uses same as the last. There is an officinal plaster prepared like the last.

Solution of Ammonia, *Cayenne Pepper*, and *Turpentine.*—All powerful and much used rubefacients, previously treated of. (See *Arterial Stimulants.*)

Sinapis. *Mustard.*

Two varieties, *white* and *black*—the seeds of Sinapis alba and S. nigra, respectively. They are small, globular seeds, inodorous and tasteless when whole; the white of a light yellowish color, the black dark-brown; both yielding on pressure a mild, fixed oil. They both make yellow powders, of a pungent, fiery taste and odor when moistened; the powder of the black variety is the stronger. *Black mustard* contains *myronic acid* and *myrosin;* the latter a substance closely allied to *emulsin;* when water is added a reaction ensues resulting in the formation from the myronic acid and

Fig. 275.

Fig. 274.

Fig. 274. Sinapis Nigra. Fig. 275. Sinapis Alba.

water of *volatile oil of mustard.* The last is pale-yellow, heavier than water, with an excessively acrid vapor, blistering and inflaming the mucous membrane of the nose; applied to the skin it produces intense irritation and inflammation. *White mustard* contains *sulpho-sinapin* and *myrosin;* when water is added a reaction ensues, resulting in the formation of a *fixed acrid principle.*

Therapeutics.—When taken whole, mustard seeds act as a gentle laxative, and are sometimes so used. The powder in small doses is a stimulating stomachic; in one or two tablespoonful doses it acts as a prompt, stimulating, mechanical emetic, and as such is very often and very usefully employed. Applied in the form of the mustard poultice (mustard plaster so-called), or *sinapism*, it is an excellent rapid rubefacient, very useful in innumerable cases of disease. The poultice should be mixed with water (*vinegar* interferes with the proper reaction), and care must be taken not to leave it on too long, as it is capable of producing very severe vesication and obstinate inflammation of the skin. This caution is especially necessary when the patient is insensible or suffering severe internal pain, as the plaster may then produce no present impression, but may be followed by an inflammation of the most obstinate character. The mustard may be diluted with flour; as a general rule, the pure mustard should not remain on longer than 20–25 minutes.

CHAPTER XXIII.

ESCHAROTICS OR CAUSTICS.

SUBSTANCES which cause a slough by destroying the life of the tissue with which they come in contact. They all act through their chemical affinity for some of the elements of the tissue, or by their chemical action on some of the proximate constituents of it. Thus caustic potash acts by its affinity for the water of a part; lunar caustic by coagulating the albumen. They are used to destroy exuberant granulations and morbid growths; sometimes to open abscesses or to form issues, or (lunar caustic and hot iron) to arrest oozing hemorrhage.

The *red-hot iron* or *actual cautery* is one of the most powerful escharotics: it is at present very rarely used.

The *moxa* consists of small rolls of muslin soaked in a saturated solution of nitrate of potassium and dried. When used, one end is set on fire, the other placed on the skin and the roll allowed to burn up. It produces a very deep eschar; was formerly used as a powerful revulsive in disease of spine, etc., at present almost never employed.

Lunar caustic and *sulphate of copper* (see Tonics), *dried alum* (see Astringents), have already been treated of. *Arsenic* (see Alteratives) is used to destroy cancerous sores, lupus, onychia maligna; dangerous from its liability to absorption. *Acid nitrate of mercury*

(see Alteratives) is especially useful in ulcers of the uterus and genitals, particularly in chancres. The *mineral acids* (see Tonics) in undiluted form are powerful caustics: nitric acid is often used to destroy venereal and non-specific warts and tubercles.

Acidum Chromicum. *Chromic Acid.*

In anhydrous, acicular crystals, of a brilliant red color, deliquescent and very soluble in water, forming an orange-yellow solution; acts on the tissues by oxidizing them, being itself converted into a sesquioxide.

Therapeutics.—A rather powerful escharotic, used chiefly to destroy small morbid growths, as specific and simple warts, mucous tubercles, etc.

Potassa. *Caustic Potash.*

Made by evaporating the officinal liquor and running the melted potash into moulds. In whitish, somewhat translucent sticks with a fibrous fracture; very deliquescent, soluble in less than its weight of water; as kept in the shops often grayish and not translucent; reaction powerfully alkaline.

Therapeutics.—A very powerful escharotic, destroying the tissue to a great depth when allowed free action. When applied care should be taken to prevent inordinate action by greasing the surrounding parts, and by washing the potash off with dilute vinegar as soon as it has acted sufficiently. Its action depends upon its great affinity for water. Issues are made with it; a piece of adhesive plaster with a hole of the size of the desired issue in the centre is placed on the skin, and then the potassa is rubbed over this.

Potassa cum Calce. Potassa with Lime. Vienna Paste.—Made by mixing an ounce each of potassa and lime; a grayish powder.

Therapeutics.—Used as a caustic: its action, though very decided, is slower and more manageable than that of caustic potash.

CHAPTER XXIV.

EMOLLIENTS.

MEDICINES which, when applied externally, soften and relax the skin; diminishing the pain and tension of inflamed parts, aiding to bring about resolution, or, if the inflammation be too far advanced, facilitating suppuration. Most of them depend for their virtues on *water*, which they all contain largely. A temperature above 62° F. is requisite for their efficiency. The cleanest and best of all emollients is the *warm water dressing;* all the various poultices, of which generally flaxseed is the best, are emollients. Bread poultices, also, are often serviceable.

CHAPTER XXV.

DEMULCENTS.

Substances of a bland, unirritating nature, mostly capable of forming a viscid solution with water. They are to the various internal mucous membranes what the emollients are to the skin. They consist chiefly of gum, starch, sugar, oil, and glycerin; and are used as protective vehicles for acrid, irritating medicines, and to defend inflamed or irritated surfaces with which they come in contact; as in inflammation of the stomach and bowels. They are much used in the acute stage of the inflammation of the mucous membranes; as in bronchitis, gonorrhœa, dysentery, etc. The starches are much given as articles of food for the sick; they are generally considered as demulcent as well as nutritious.

Acacia. *Gum Arabic.*

The product of several species of Acacia, A. Arabica, vera, etc.; exudes naturally and is obtained through incisions; said to be most plentiful in the driest, hottest weather, and on old sickly trees. There are several varieties. *Turkey Gum*, that ordinarily kept in our shops, consists chiefly of small, irregular fragments, whitish or tinged with yellow, interspersed with larger globular masses, which are frequently opaque from very numerous cracks. *Senegal Gum*, generally in roundish, or oval, unbroken pieces; larger and less brittle than the Turkey gum, and with a more conchoidal fracture. *Barbary Gum* resembles a mixture of the preceding. *India Gum*, in irregular pieces, less chunky than the Turkey, containing numerous impurities. Pure gum Arabic is composed of a substance, *arabin*, wholly soluble in water. This is composed of *gummic acid*, with 3 per cent. of lime; or in other words, it is a *gummate of calcium*; by the action of a heat of 300° F., for several hours, gummic acid is changed into the isomeric *meta*-gummic acid, which is not soluble in water, merely swelling up; by boiling water the salts of metagummic acid are converted into gummates. Cerasin, the principle of cherry and many other gums, is a *metagummate of calcium*, and has the peculiar characters just mentioned.

Fig. 276.

Acacia Arabica.

Therapeutics.—Used as a demulcent in cough mixtures, and for dysentery; also in pharmacy in compounding pills and emulsions.

Mucilago Acaciæ. Mucilage. (℥iv–Oj.)

Syrupus Acaciæ. Syrup. (A. ℥ij; sug. ℥xiv; water f℥viij.)—Both may be used freely.

Tragacantha. *Tragacanth.*

Product of several species of Astragalus, chiefly A. verus; small, thorny shrubs of Persia and Asia Minor. Occurs in hard, hornlike flakes, of a yellowish-white color; hard to pulverize; brittle when very dry. Insoluble in water, but swelling up and forming a dense mucilage. Contains some *arabin*, but chiefly composed of *bassorin*, or *tragacanthin;* characterized by its insolubility and swelling up in water.

Therapeutics.—Employed only as a vehicle. The foundation of the officinal troches.

Mucilago Tragacanthæ. Mucilage. (℥j–Oj.)—Used to suspend heavy powders.

Ulmus Fulva. *Slippery-Elm Bark.*

The inner bark of Ulmus fulva, a tree of the northern United States. It is stripped off in long pieces, and folded longitudinally; of a tawny color; fibrous texture; slight peculiar odor; peculiar, mucilaginous, sweetish taste; affording with water an elegant mucilage.

Therapeutics.—Used as emollient in form of poultice made with ground bark or in thick mucilage, in various external inflammations; as demulcent in dysentery.

Mucilago Ulmi. Mucilage. (℥j–Oj.)—Dose, *ad libitum.*

Linum. *Flaxseed.*

The seeds of Linum usitatissimum, or common flax. About a line in length; flattened, oval, brown, shining. Contain a fixed oil, and large amount of mucilage. The oil is obtained by expression, and is known as *linseed oil* (*Oleum Lini*, U. S.). Yield their mucilage to water, especially when hot. The mucilage should be made by putting the seed in a little bag (℥j–Oj), in boiling water, and allowed to *simmer* but not *boil*, until the mucilage is formed; lemon juice and sugar may be added to make it more agreeable.

Fig. 277.

LINUM USITATISSIMUM.

Therapeutics.—Infusion much used as a demulcent and diluent in kidney affection, etc.

Infusum Lini Compositum. Compound Infusion. (L. ℥ss; liquorice root ʒij; boiling water Oj.)—Used in bronchitis, *ad libitum.*

Glycyrrhiza. *Liquorice Root.*

The root of the Glycyrrhiza glabra of South Europe.

Extractum Glycyrrhizæ. Liquorice.—The extract of the root.

The root is found in the shops in long, cylindrical pieces; brownish externally, yellowish within; from a few lines to half an inch in thickness; sweetish, peculiar taste. The extract is black, hard, of a sweet, peculiar taste. Sweet principle, *glycyrrhizin*, which is not a sugar, and forms salts with bases. Contains also *asparagin*, starch, acrid resin, etc.

Therapeutics.—An excellent demulcent in pectoral complaints; used also on account of its agreeable taste; may be chewed or taken in infusion.

Mistura Glycyrrhizæ Composita. Compound Mixture. Brown Mixture.—(Extr. glycyrrh., sugar, gum Arabic, āā ℥ss; paregoric f ʒij; antimonial wine f ℥j; sweet spirit of nitre f ℥ss; boiling water f℥xij.) An excellent demulcent, sedative cough mixture; used in the early stage of bronchitis. Dose, f ʒij to f ℥ss.

Trochisci Glycyrrhizæ et Opii. Troches. Wistar's Lozenges.—Each contains $\frac{1}{8}$ gr. opium; used in allaying cough.

Cetraria. *Iceland Moss.*

Fig. 278.

CETRARIA ISLANDICA.

The Cetraria Islandica, a lichen growing on the rocks in polar countries. The frond is from two to four inches long; dry, coriaceous, smooth; brown above, grayish-white below; of a bitter mucilaginous taste; odorless; yields to boiling water. Mucilaginous nutritious principle, *lichenin* (*lichen starch*), strikes a blue with iodine. Bitter principle, *cetraric acid;* may be removed by soaking in a very weak, cold alkaline solution.

Therapeutics.—Used as demulcent article of diet in various inflammatory affections.

Decoctum Cetrariæ. Decoction. (℥ss–Oj.)—Dose, f℥j–iij, every three or four hours.

Chondrus. *Irish Moss. Carrageen.*

Chondrus crispus, a sea weed, growing on the rocks on the coasts of Ireland and Northern Europe. Consists of a cartilaginous frond, several inches long, curled, bleached to a yellowish-white; odor and taste feeble; yields to boiling water. Contains *carrageenin*, a substance closely resembling pectin. Used as the last.

Maranta. *Arrowroot.*

The fecula of the rhizome of Maranta arundinacea, of the West Indies. Obtained by beating the long, swollen rhizome into a pulp, mixing with water, stirring and straining to separate the fibre, and drying. The best is prepared in Bermuda. A white product; tasteless, odorless; under the pocket lens shows numerous glistening points; a pure starch.

Therapeutics.—Affords an elegant, demulcent, farinaceous arti-

cle of diet for the sick: in preparing, a paste should be first made with a little cold water, and this added to boiling milk or water. A tablespoonful is enough for a pint.

Tapioca.

The fecula of the large, fleshy root of the Janipha manihot or cassava plant of the West Indies. There are two varieties of the root, the bitter and the sweet. The former is poisonous, containing prussic acid, but this being driven off by heat, cooking renders it innocuous. The tapioca is obtained by expressing the juice and allowing it to deposit its fecula, which is afterwards dried by heat. Occurs in irregular, hard, white grains; odorless, tasteless; used as a farinaceous article of food. Prepared by prolonged boiling in milk or water, which converts it into a sort of jelly.

Sago.

A fecula obtained from the Sagus rumphii or Sago palm of the East Indies. Obtained by splitting open the trunk just before flowering, scooping out the pith, agitating it with water so as to separate the starch, removing the fibre by passing through a sieve, allowing the fecula to settle, and drying. This is *Common Sago;* it is in large, dull brownish, irregular grains. *Pearl Sago* is a finer variety, prepared by the Chinese, in small, round grains, hard, whitish, somewhat translucent; odorless, tasteless. Chemically a pure starch. Requires long boiling for its preparation. Uses and mode of preparation similar to those of tapioca.

Hordeum. *Barley.*

The decorticated seeds of Hordeum distichon, or barley. Prepared for medicinal use by cleaning, rounding, and polishing the grain in a mill (*pearl barley*). Small, white, oval grains, furrowed along one side. Contains starch, gum, sugar, gluten; yields to boiling water. Used as an article of food and as a demulcent.

Decoctum Hordei. Barley Water.—Made by taking barley ℥ij, washing well, then boiling for a short time with Oss water; then throwing the liquid away, and finally boiling with Oiv water down to Oij. Used as a drink in inflammatory and febrile conditions of the system; may be flavored with lemon-juice and sugar.

Glycerin.

A syrupy, almost colorless liquid. Obtained in the saponification of oils and fats. Chemically, it is analogous to the alcohols. Specific gravity, 1.26. It is freely soluble in water and alcohol; and will dissolve many substances, acid, basic, and neutral. When strongly heated, it gives off vapors of *acrolein.* Permanganate of potassium decomposes it.

Therapeutics.—Internally, glycerin is a bland, gentle laxative, suitable for children, in the dose of one or two fluidrachms. It is emollient to the throat in croup, diphtheria, and scarlet fever. Being decidedly *antiseptic*, it is a valuable agent for washing out the vagina in various uterine affections. But its principal uses

are, those of a vehicle or adjuvant, in various preparations; chiefly for external application. Five *glycerites* (glyceroles) are officinal, U. S. P.; viz., those of Borate of Sodium, Carbolic Acid, Gallic Acid, Tannic Acid, and Tar.

CHAPTER XXVI.

DILUENTS.

Liquids which dilute the contents of the alimentary canal, enter the bloodvessels, and are given off by the emunctories, diluting and rendering more fluid the secretions. Water is the active principle of them all, and is in fact the one great diluent. They are especially useful to render the urine less irritating in various inflammations of the urino-genital apparatus. The demulcents afford the best diluent drinks, and may be flavored to suit the taste of the invalid.

CHAPTER XXVII.

ANTACIDS.

Medicines which unite with and neutralize acids. They are the alkalies, alkaline earths, and various carbonates, which are capable of being decomposed by free acid in the alimentary canal. Their chief use is to neutralize an excess of acid in the alimentary canal in various forms of dyspepsia, diarrhœa, etc. As they render the urine alkaline, they are also administered in uric acid diathesis.

Liquor Potassæ. *Solution of Potash.*

Made by adding lime to a solution of the bicarbonate. A limpid liquid, strong alkaline reaction, and acrid, alkaline taste. Sp. gr. 1.065, contains 5.8 per cent. of hydrate of potassium. Dose, gtt. iij–viij.

Calx. *Lime.*

Used only in the form of *Aqua calcis*, *Lime-water.* Made by dissolving lime in water; should always have some lime in the bottom of vessel, so as to keep it saturated; colorless, alkaline taste and reaction; readily attracts carbonic acid from the air, and deposits carbonate.

Therapeutics.—A sedative antacid; very useful, combined with equal quantity of milk, as a remedy for sick stomach. Dose, f℥ss. Mixed with linseed oil saponifies, making a very thick fluid (*carron oil*), which is useful as a local application to burns.

Creta. *Chalk.*—Native. friable carbonate of calcium.

Creta Præparata. Prepared Chalk.—Chalk with impurities and coarser particles separated by levigation; occurs in white powder, or white conical masses; insoluble, but forming a smooth mixture in water.

Therapeutics.—Antacid and somewhat astringent; used in diarrhœa. Dose, gr. v–xv every two or three hours.

Mistura Cretæ. Chalk Mixture. (Prep. ch. ℥ss, Sugar, Gum Arabic, āā ʒij; Cinnamon water, Water, āā ℥iv).—Combined with vegetable astringents and opiates, it forms a very valuable remedy in diarrhœa. Dose, f ℥ss.

Testa Præparata. Prepared Oyster Shell.—Finely pulverized and levigated oyster shell; same uses and dose as prepared chalk, from which it differs only in containing some little animal matter.

Calcii Carbonas Præcipitata. Precipitated Carbonate of Calcium.—Made by reaction between a solution of carbonate of sodium and chloride of calcium. A white, insoluble, tasteless powder. Uses same as prepared chalk.

Magnesia and *Ammonia* have been already treated of.

Liquor Sodæ. *Solution of Soda.*

Made by action of lime on a solution of the carbonate. A colorless liquid, alkaline taste and reaction. Sp. gr. 1.071; contains 5.7 per cent. of hydrate of sodium. An antacid. Dose, gtt. iij–viij. Used chiefly for pharmaceutical purposes.

Lithii Carbonas. *Carbonate of Lithium.*

A white powder, sparingly soluble in water. Commended by Dr. Garrod and others, especially in the treatment of *gout*, to neutralize an excess of uric acid in the blood. Dose, gr. iij–vj.

Citrate of Lithium is also used, and is officinal. Dose, gr. v–x.

CHAPTER XXVIII.

ANTHELMINTICS.

These are medicines which produce or promote the expulsion of worms from the alimentary canal. They accomplish this in two ways: 1st, by killing the worms; 2d, by so exciting the peristaltic action of the bowels that the parasite is unable to retain its position, and is carried out of the intestines. Those acting in the former way are *vermicides;* the others are *vermifuges*. Such are the drastic cathartics; these are more effective when the worms have been previously weakened by medicinal or other causes.

Spigelia. *Pink Root.*

The root of Spigelia marilandica, a native of the southern and western United States. A knotty head giving origin to numerous

slender, crooked, wrinkled, branching rootlets; of a brownish color; faint, peculiar odor; sweetish, bitterish taste. Yields to boiling water. Contains gallic acid, volatile and fixed oil, and a bitter, uncrystallizable substance, thought to be the active principle.

Fig. 279.

Spigelia Marilandica.

Therapeutics.—A powerful vermicide, used against the round worm. In large doses an uncertain cathartic, and a narcotic; is said to have caused fatal convulsions in children. Dose, for a child (4 yrs.) gr. x–xx, morning and evening for two or three days, followed by a brisk cathartic.

Infusum Spigeliæ. Infusion (℥ss–Oj).—Dose, f℥ss.

Extractum Spigeliæ Fluidum. Fluid Extract.—Dose, fʒss–j.

Extractum Spigeliæ et Sennæ Fluidum. Fluid Extract of Senna and Pink Root.—Dose, fʒj–ij.

Chenopodium. *Wormseed.*

The fruit of the Chenopodium anthelminticum, a native of the United States. Globular; size of pin's head; dull greenish-yellow or brownish; strong, peculiar odor; bitterish, pungent, aromatic taste. Active principle, a volatile oil.

Therapeutics. — A vermicide; adapted to cases of round worm. Dose, ℈j–ij, in molasses, followed by an active cathartic.

Oleum Chenopodii. Volatile Oil.—Yellowish, darkening with age. Dose, gtt. v–xx.

Santonica. *Semen Contra.*

The unexpanded flowers of Artemisia contra and other species. Two varieties: *Barbary*, covered with whitish down: *Levant*, green, without down; odor aromatic; taste bitter, peculiar.

Active principle *Santonin* (SANTONINUM, U. S.); crystallizable; nearly insoluble in water, soluble in alcohol and ether; colorless, forming salts with alkalies. An active vermicide. Dose of Santonica, gr. x–xx; of Santonin, gr. ij–iij, followed by cathartic.

Azedarach.

The bark of Melia azedarach, or Pride of China; a native of Asia, but largely planted in Southern United States as an ornamental tree. Used only in fresh state; bitter, nauseous taste; yields to boiling water. An efficient vermicide and vermifuge against the round worm. In large doses an acrid emeto-cathartic and narcotic. Given in decoction (℥j–Oj). Dose, fℨij–iv.

Mucuna. *Cowhage.*

The hairs of the *f* shaped pods of the Mucuna pruriens, of the East and West Indies. Brown, bristle-like; short, very hard and

Fig. 280.

MUCUNA PRURIENS.

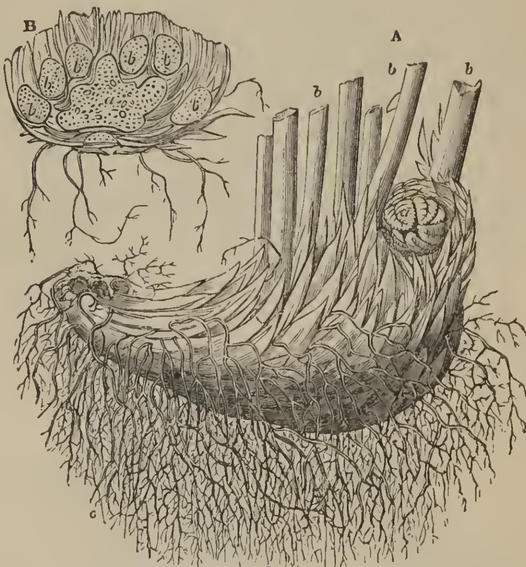
sharp at the point. Kill the round worm by piercing him. Given in electuary; rarely used. Dose, ℨj–ij, followed by a cathartic.

Filix Mas. *Male Fern.*

The rhizome of the Aspidium filix mas, a European fern. A long, cylindrical rootstalk, thickly covered with the imbricated bases of leafstalks, and giving origin to numerous rootlets; often

kept in shops in fragments, and much deteriorated. Odor faint, peculiar; taste sweetish, bitterish, nauseous, astringent. Contains volatile oil, gallo-tannic acid, etc.

Fig. 281.



ASPIDIUM FILIX MAS.—Fresh rhizome entire. *a.* Spirally coiled young frond. *b, b, b.* Foot-stalks of older fronds. *c, c.* Root-fibres.

Therapeutics.—Slightly tonic and astringent; an active vermicide against the tapeworm. Dose, of powder, ʒj–ij; an ethereal extract is used in 12–24 gr. doses.

Pepo. *Pumpkin Seed.*

The seeds of Cucurbita pepo, or common pumpkin. Oval, flatish, about 9 lines long, by 5–6 broad, with a distinct groove near the edge on each side. Odor and taste slightly sweetish and aromatic. Contains fixed oils, sugar, gum, etc. A very efficient vermicide against the tapeworm. Dose, ℥ij, taken in the morning, fasting, and followed by castor oil; given in emulsion, or beaten up into a paste with sugar. The fixed oil is said to have been successfully used in f℥j dose.

Brayera. *Kooso.*

The flowers and unripe fruit of Brayera anthelmintica of Abyssinia. Greenish-yellow; odor fragrant; taste slight at first, afterwards acrid, disagreeable. Given in cases of tapeworm in ℥ss dose, mixed with water.

Rottlera. *Kameela.*

The powder and hairs obtained from the capsules of Rottlera tinctoria of Southern Asia. A light, finely granular, brownish-red powder, with little smell or taste, producing some acrimony in the mouth. Contains a crystallizable principle, *Rottlerin;* active principle, a resin. Used against the tapeworm in dose of ʒj–iij, in emulsion or tincture.

Oil of turpentine, the *bark of the Pomegranate root*, and *Calomel*, which are all used as anthelmintics, have been elsewhere treated of.

A MANUAL

OF

PRACTICE OF MEDICINE.

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PRACTICE OF MEDICINE.

CLASSIFICATION OF DISEASES.

THE following classification, that of Dr. W. Farre, has met with much favor :—

CLASS I.

ZYMOTIC DISEASES. *Zymotici.* Diseases that are either epidemic, endemic, or contagious ; induced by some specific matter, or by the want of food, or by its quality. In this class are four orders.

ORDER 1. *Miasmatici.* Examples : Smallpox, Hospital Gangrene.
2. *Enthetici* (implanted diseases). Ex. : Syphilis, Hydrophobia.
3. *Dietetici.* Ex. : Scurvy, Alcoholismus.
4. *Parasitici.* Ex.: Scabies, Tapeworm.

CLASS II.

CONSTITUTIONAL DISEASES. *Cachectici;* sporadic diseases, affecting several organs of the body.

ORDER 1. *Diathetici.* Ex.: Anæmia, Cancer.
2. *Phthisici.* Ex. : Scrofula, Phthisis.

CLASS III.

LOCAL DISEASES. *Monorganici* (affections of one organ).

ORDER 1. BRAIN DISEASES. *Cephalici.*
2. HEART DISEASES. *Cardiaci.*
3. LUNG DISEASES. *Pneumonici.*
4. BOWEL DISEASES. *Enterici.*
5. KIDNEY DISEASES. *Nephritici.*
6. GENETIC DISEASES. *Genetici* (of organs of reproduction).
7. BONE AND MUSCLE DISEASES. *Myostici.*
8. SKIN DISEASES. *Chrotici.*

CLASS IV.

DEVELOPMENTAL DISEASES. *Metamorphici.*

ORDER 1. OF CHILDREN. *Paidici.*
2. OF WOMEN. *Gyniaci.*
3. OF THE AGED. *Geratici.*
4. OF NUTRITION. *Atrophici.*

In the following pages, for reasons of obvious convenience, this classification will not govern strictly the order of succession in our consideration of diseases.

CHAPTER I

ZYMOTIC DISEASES.

Variola.

Synonym.—*Smallpox.* Varieties.—Discrete and confluent; also, *varioloid* or modified smallpox, after vaccination.

Symptoms and Course.—*Stages:* These are, incubation, primary fever, eruption, secondary fever, and desquamation. The incubation (period between exposure to the contagion and beginning of the attack) lasts about twelve days. The first symptoms are languor, headache, vomiting, and severe pain in the back; soon developing into fever. On the third day of this, pimples, at first small and red, appear, first on the face, then on the neck, arms, trunk, and lower limbs. These papules become vesicles and then pustules; suppurating perfectly by the ninth day of the fever. Then they flatten and scab. Four or five days later, about the fourteenth day of the fever, these scabs begin to fall off. Desquamation is commonly completed by the end of the third week of the attack. To recapitulate: there are, after about twelve days of incubation, three of primary fever, six or seven for the coming out and maturing of the eruption, four or five for its scabbing, and six or seven for desquamation.

These periods vary somewhat. The severity of the disease depends mostly upon the amount of the eruption. This makes the difference between the discrete (scattered, separate) and confluent smallpox. Even the primary symptoms are generally worse in the latter. The secondary fever, connected with the full development of the eruption (about the eleventh day of disease), is much the most severe in the confluent. The suffering of the patient is great, even extreme, in this form, the whole surface of the body being covered with inflamed pustules. Even the eyes, mouth, and throat may be invaded. Blindness sometimes follows. A peculiar and disagreeable odor emanates from the body in confluent cases.

Malignant smallpox is simply a violent form of it, characterized by rapidity, and extreme prostration, with or without extensive pustulation. The eruption, in it, is sometimes attended by lividity of the skin. Delirium is common, and a typhoid stupor may exist.

After smallpox, abscesses in various parts of the body, hard glandular enlargements, ulceration of the cornea, suppuration of the ear, pneumonia, or pyæmia may occur.

The danger to life in this disease is always serious Before vaccination, thousands died annually from smallpox.

Causation.—There is no disease more certainly contagious than variola. Generally either contact or approach within a few feet seems necessary for its conveyance. In the large majority of

eases, smallpox occurs but once in a lifetime. Exceptions are well known, however; some in which the same person has had it three—it is *said*, even five times.

TREATMENT.—The fever calls, first, for a cooling laxative dose, as Rochelle salt or citrate of magnesium. Then, refrigerant diaphoretics will be in place; as *neutral mixture*, *effervescing draught*, or *liquor ammonii acetatis*. No *cutting short* of smallpox is possible; it is a self-limited disease. There is no specific remedy for it; we can palliate it only, and conduct the patient through it.

So decided is the tendency to exhaustion of the system in severe smallpox, that early support by concentrated liquid nourishment must be the general rule. Milk, in small quantities, often (one or two tablespoonfuls every two or three hours), and chicken or mutton broth, or beef-tea must be given. Other sick diet, as gruel, arrowroot, toast-water, etc., may do during the primary fever. But a good many cases will require even wine-whey or whiskey punch in the second and third weeks; malignant cases, perhaps, in the first. Quinine should go with these, in tonic doses; *e. g.* one or two grains every three or four hours. An opiate at night is often serviceable, especially in the confluent form. *Sarracenia purpurea* is of no use whatever in smallpox.

An important object often is, to prevent *pitting* of the face. Three plans are resorted to: 1. To abort the vesicles. 2. To soothe and mitigate the inflammation connected with them. 3. To exclude air and light during the scabbing and desquamation. The first of these ends is sought by touching each pimple, on the face, on the fourth or fifth day of the attack, with a point of lunar caustic. Soothing inflammation is aimed at by covering the whole face during the first week with a soft poultice of bread and milk, flaxseed meal, or slippery elm bark. Exclusion of the light may be obtained by gold leaf; of air, by mercurial ointment, or collodion, softened by adding $\frac{1}{50}$th part of glycerin before it is painted upon the face.

The *sequelæ* of smallpox must be treated as they arise, by the opening of abscesses, improving the tone of the system by iron, etc. Great care is needed in convalescence from this, as from other acute (especially eruptive) diseases, not to be exposed to sudden changes or extremes of temperature. The danger of pneumonia, pleurisy, or bronchitis is, at such times, much greater than usual.

Varioloid: Modified Smallpox.—In those who have been vaccinated, while the liability to be affected by the virus of smallpox is in most cases removed, in a few the disease is taken on exposure, in a milder form. The primary fever is rather less severe, the eruption is more scattered, the pustules are not so deep nor so much inflamed, they scab sooner, and very rarely *pit;* and there is no secondary fever. Varioloid is seldom fatal. Its treatment should be essentially the same as that of smallpox; only there is less often need of special measures to prevent marking of the face.

Vaccination.

The ancient practice of inoculation with smallpox, while it was, by the mildness of the attack, nearly always protective of the

individual, at the same time propagated the disease, multiplying the amount of its virus. Jenner's introduction into professional practice of inoculation with the virus of cow-pox, known before his time among dairymen, has greatly abridged not only the destructiveness, but the prevalence of variola.

Whether "vaccinia," or cow-pox, is smallpox affecting the cow, or is a different disease whose virus is protective against smallpox, is not yet determined to the satisfaction of all investigators. Experiments have been tried repeatedly, with conflicting results. Either way, the facts are plain, that most persons are, by one good vaccination, protected for life; that modified smallpox, occurring in the vaccinated, is very seldom indeed fatal, and hardly ever pits; and that repeated vaccination, after an interval of years, will make protection almost always complete.

Vaccination may be performed either with the fresh lymph, the same dried by keeping, or the scab; and, either directly from the udder of the cow, or from a human being inoculated with cow-pox. In Europe the lymph of the vesicle, before maturation, is generally preferred. In this country the scab is much used, and is found reliable, when fresh enough. No matter how it is kept, after a month it is uncertain; although it has sometimes been found efficient after being sealed up for a year; especially when mixed with glycerin.

Direct inoculation from the cow often makes a very sore arm, with considerable fever. For infants, unless rugged in health, this is an undesirably severe process. It is, at the same time, probable that many transits through human bodies may somewhat modify the virus. Renewal, by inoculating healthy children, not too young, every now and then, from the udder of the cow, is to be recommended. Cattle with the cow-pox may be found in almost any agricultural neighborhood.

In the absence of smallpox, the second month of infancy will be time enough for vaccination. But under danger of exposure, a babe should be vaccinated at any time after birth. Matter only from healthy children ought ever to be used. While it is unlikely that any constitutional disease (as syphilis[1] or scrofula) can be so introduced, there should, in practice, be no room left for any doubt of the kind; and some cutaneous diseases might certainly be transmitted. Unless on account of risk from exposure, the existence of an eruption on the skin, or any other indisposition of the child itself, may be a reason for postponing the operation. The excitement produced by it may aggravate an existing inflammatory affection. Vaccination has often been blamed for the breaking out of eruptions, supposed to be transmitted, when their cause was really the state of the system of the patient.

For the operation, the outside of the arm near the shoulder is commonly selected. The exact method used is not important. A small, wedge-shaped lancet, or even a sharp-pointed penknife, will do. Various slides have been contrived for the purpose. I

[1] In Italy, western France, and elsewhere, a number of cases of syphilitic disease (primary and secondary), following impure vaccination, have been reported.

prefer to cut or push out a very small flap of cuticle, under which a thick paste, made by pressing and mixing a portion of the scab with a drop of tepid water, may be inserted. The art of the operation is, to pierce the skin without drawing enough blood to flow; it is most successful when there is no blood at all. Besides the flap, it is as well to scratch the skin, and puncture it, at a little distance, giving three chances of taking instead of one. No disturbance of the arm must be allowed for twenty minutes or half an hour afterwards.

If it be successful, no sign of it is distinctly visible for two or three days. On the fourth day a decided, small red pimple is to be seen and felt. This becomes a vesicle of some size on the fifth day; it grows large and cylindrical, or hat-shaped, and by the tenth or eleventh day is fully umbilicated, or depressed like a navel in the centre. Before that, about the eighth day, the bright red ring or *areola* forms around it. This fades after the eleventh day, and the vesicle dries up into a round and flat, but rather thick, mahogany-colored scab, which falls off about the nineteenth day. All of these particulars are important, as showing the genuineness of the vaccination. So is the appearance of the cicatrix left; which should be large in proportion to the vesicle, and *dotted* or marked with subdivisions. This is owing to the vesicle being composed of several small cells or compartments.

Slight fever, with restlessness, is not unfrequently observed during the first few days after the vesicle appears; but there is rarely anything requiring treatment.

Re-vaccination.—Experience shows that a small number of persons, after several years, reacquire the susceptibility to smallpox. As the only test of this is exposure either to the latter or to *vaccinia*, the renewal of the latter, at least once after puberty, is always advisable. On the occasion of epidemics of smallpox, it may be repeated again and again. There is no pain of any consequence in this operation, nor danger, and, if a genuine vesicle forms, making a sore arm, that discomfort for a few days cheaply purchases immunity from the terrible disease. Certainly smallpox is extremely rare in re-vaccinated persons.

The virus from a second vaccination should not be relied upon for use.

Varicella.

SYNONYM.—*Chicken-pox.* This is a mild exanthematous disease resembling smallpox or varioloid considerably. After an incubation of four or five days from exposure to the contagion of one having it, pimples form, generally scattered widely. In the second day they become vesicles filled with lymph. Two or three days more find them scabbing; they dry and fall off soon, without pitting except in rare instances. There is little or no fever or other indisposition. The disease is attended with no danger to life, and requires only precautionary treatment, *i. e.*, to avoid exposure to cold and wet, to keep the bowels regular, and, if needful, promote action of the skin by a diaphoretic, as neutral mixture.

The eruption of varicella differs from that of variola in coming

out in successive crops; in not suppurating or becoming umbilicated; and in not deeply involving the true skin.

Scarlatina.

SYNONYM.—*Scarlet fever.*

VARIETIES.—Scarlatina *simplex*, *anginosa*, and *maligna*.

SYMPTOMS AND COURSE.—After an incubation, supposed to be about five days after exposure to its cause, lassitude, anorexia, headache, and pains in the back and limbs mark the beginning of the attack. Soon these are followed by fever; on the first day, very often, the throat is sore. On the second day, usually, a punctated red eruption appears on the face and neck, and in ten or twelve hours has covered the whole body. It is of a scarlet, or sometimes a brick-red hue, uniformly diffused, with a swollen appearance, and great heat; reaching by the thermometer even 106° Fahr. Occasionally miliary vesicles are seen. There is also a sense of burning and some soreness or irritation of the skin. The tongue has a strawberry-like look, from the projection of enlarged red papillæ through a whitish fur. The throat is very red and swollen, generally with a hue not unlike that of the skin. Fever runs very high, with an extremely rapid pulse, great thirst, headache, perhaps delirium, costiveness, in some cases vomiting. Bad cases may have stupor. By the fifth day mild examples of the disease show already an abatement. Most have passed the height of the pyrexia by the ninth; although *sequelæ* may protract the attack much longer. Malignant cases may be fatal in a day or two, or even in less than twenty-four hours. Desquamation of the skin follows the fading of the eruption; often large masses of cuticle coming away at once. At this stage more or less decided albuminuria is common.

Scarlatina Simplex.—In this the eruption comes out early and well, with moderate fever, little inflammation of the throat, and an even course throughout. Sometimes there is hardly any febrile disturbance; and the child may play about without having to go to bed.

Scarlatina Anginosa.—Here the violence of the disease falls upon the throat chiefly. The tonsils swell greatly, suppurating either early or late, or they are covered by pseudo-membranous deposit, white, gray, or dark-brown, whose coming away leaves an ulcerous surface, with in some instances an acrid, offensive discharge. The extension of the ulcerative inflammation may pass the Eustachian tube to the tympanum, and even may destroy the auditory apparatus so as to cause permanent deafness. After the rash has disappeared, abscesses in the neck may form and discharge, exhausting the patient.

Scarlatina Maligna.—This term designates an overwhelming toxæmic impression of the morbid cause of the disease. Depression in the first stage becomes intense, without reaction; or, after the eruption has partly come out, it recedes, or grows livid in appearance; or the brain is oppressed with coma. Coldness is sometimes present, or unequal temperature of different parts of the body, instead of the usually diffused febrile heat. The throat may be much or little affected. In some instances the patient seems

almost as if struck by lightning—so sudden and deep is the general prostration. In this condition death may take place in a few hours. Otherwise, with continued prostration, hemorrhage from the stomach or bowels, vomiting, or diarrhœa threatens an untoward result.

SEQUELÆ.—Abscesses about the throat have been mentioned: similar local affections may take place elsewhere after the attack. Ozæna is not uncommon; neither is suppurative inflammation of one or more of the joints, or of the testicle; nor vaginitis. Endocarditis or pericarditis may occur. So may paralysis; either hemiplegia or paraplegia; generally it is partial, and it is often slowly recovered from.

Dropsy, from arrested action of the kidneys, with imperfect action of the skin, is the most common and in many cases the most serious of the sequelæ of scarlatina. It comes most frequently within a week or two after desquamation has commenced. Mild cases are almost as likely to be followed by it as severe ones. Exposure to cold is the generally observable direct cause; but cases happen in which no such exposure could have existed. Anasarca is the least dangerous though most frequent form of this dropsy. There may, instead or in addition, be ascites, hydrothorax, or hydrocephalus. Albuminuria, and often hæmaturia, accompanies either form.

DIAGNOSIS.—From measles scarlet fever is known by the eruption coming out on the second day, without catarrhal symptoms but with sore throat—and by its being of a brighter red color, and uniformly diffused instead of being in patches.

From roseola, it is distinguished by the fever and sore throat, and by the rash, in the latter, being in irregular blotches, damask rose color instead of the brick or scarlet-red hue.

PROGNOSIS.—This is proverbially *uncertain* in scarlet fever. The simple form is, however, the least dangerous, and a very large majority of cases get well. The anginose is more threatening and serious. But the malignant variety, as its name indicates, is far the most so; recovery from it is the exception, although it does occur. Adults are, when affected with scarlet fever, in somewhat greater danger than children; and so, especially, are puerperal women.

CAUSATION.—Although most (not all) authorities agree that this disease is contagious, it is certainly very capricious or variable in its manifestation of this quality. That is, many persons who are exposed escape it. It is true, that several children in a family often have it in immediate succession. But the escape of all but one is common. It rarely occurs twice in the same person.

TREATMENT.—Mild cases require no medication at all, other than to make sure that the bowels are well opened. If fever is high, after a saline cathartic, as citrate or sulphate of magnesium, or Rochelle salts, neutral mixture or effervescing draught, or liquor of acetate of ammonium may be given. Sweet spirits of nitre may be added, in small dose ($\frac{1}{4}$ to $\frac{1}{2}$ fluidrachm for an adult, and proportionately less for a child) if the kidneys act slowly. Drinking cold water freely is to be encouraged; as it is demanded by thirst.

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If the throat be much inflamed, the frequent melting in the mouth of ice, in small pieces, will do good.

For the sore throat, which is *specific* in character, besides the use of leeches externally if the inflammation be great and the case sthenic, local alteratives may be used. An old and popular gargle is one of red pepper, vinegar, and water. More powerful in changing the character of the inflammation is a strong solution of nitrate of silver (gr. xxx in f℥j) applied with a large hair pencil.

For the irritation of the skin connected with the rash, relief is to be obtained by sponging with cool or tepid water, two or three times a day. Inunction with lard, or glycerin, is preferred by some. Cold *affusion* is more troublesome and less safe.

The diet in scarlet fever should be, as a rule, liquid, but need not be *low*, generally, in the sense of dilution or exclusion of animal material, unless in the first few days. Sooner than in most diseases, the tendency to debility is manifest. Then, milk, chicken broth, mutton-tea or beef-tea, etc., will be suitable. At the same stage, some patients will require a tonic treatment, by quinine, or, as some prefer, nitric acid in small doses.

Malignant scarlatina is a disease of terrible depression from the outset. Deficient reaction is one of its characteristics. To promote this, external stimulation is primarily important. The hot salt or mustard bath is a powerful agent for the purpose. *Urtication, i. e.*, the direct application of fresh nettles, has been sometimes employed. Mustard plasters may be applied energetically; and so may hot bottles, or bags of hot salt, etc. Internally, ammonia, quinine, and capsicum are the most prompt and reliable stimulants, although we may add to the same list, Hoffmann's anodyne, and brandy, whiskey, or wine. Where a tendency to *stupor* exists, *free purging* will be the main hope. Jalap is a convenient article for the purpose.

The sulphite of sodium is now, very reasonably, under trial in various zymotic diseases, as an antagonistic of morbid blood-changes. The dose for an adult (perhaps not yet well settled) may be about ten grains every two or three hours. Chlorine water, in fluidrachm doses for an adult (ten drops for a child of two years), is sometimes given in scarlet fever with a similar view; and so is chlorate of potassium.

Other modes of treatment for severe cases are, the use of tincture of chloride of iron freely; of quinine in considerable doses; of infusion of digitalis; of diluted acetic acid (ʒj to ʒiv of the officinal acid in f℥iv of water, the dose of the solution being a tablespoonful, sweetened, every few hours); and of diluted nitric acid.

Of the *sequelæ* of scarlet fever, each has its own indication for treatment. That of dropsy is the most frequently important. If, during desquamation, the kidneys show any threatening of inaction or suppression, the greatest care of the state of the skin must be maintained. It is, indeed, a good rule of precaution, for fear of some carelessness or exposure, not to allow a patient recovering from scarlet fever to leave his chamber for three or four weeks at least from the beginning of the attack, nor the house for four or five. Lemonade as a drink, if the urine be scanty, may be freely used. Cream of tartar and acetate of potassium are approved in

the same cases as diuretics. Digitalis has the confidence of many. *Quinine*, in doses large enough to cinchonize, is reported very favorably of, in scarlatinal dropsy, by some practitioners. Dry cupping to the lumbar region, and the application there of a large mustard plaster, are measures suggested by the known congested state of the kidneys. Purgatives must not be omitted when diuretics fail; the principles governing their use being the same as in other varieties of dropsy.

Prophylaxis.—Belladonna has been asserted to have a protective power against the contagion or infection of scarlet fever. But the evidence in its favor does not appear to warrant our giving any confidence to it, or to any prophylactic.

Measles.

SYNONYM.—*Morbilli.* Formerly, with all writers, and still with many, *rubeola* is a synonym for measles. Some English writers, however, designate by the name of rubeola only a hybrid or blending of measles with scarlatina.

SYMPTOMS AND COURSE.—After an incubation of from ten to fifteen days from exposure to its contagion, measles begin with a slight or obscure stage of depression passing into fever. With this there are all the symptoms of a cold; running at the nose, redness and watering of the eyes, and a cough. On the fourth day of the attack the rash begins on the face, and extends over the body and limbs. It is not so bright in color as the eruption of scarlet fever; and is irregularly distributed in patches, more or less crescentic in shape. By about the seventh day the rash begins to fade, and about the same time or before the fever has begun to decline. Desquamation is much less extensive than after scarlatina.

No such intensity of febrile movement, nor severity of any kind, as is common in the last-named disease, exists, except very rarely, in measles. *Camp* measles, during the late war in this country, often assumed a typhous character, with considerable mortality; due to the conditions under which it occurred among the soldiers. Otherwise measles seldom threaten life.

The *sequelæ* which are of the most consequence are, ophthalmia, diphtheria, chronic bronchitis, and phthisis. Very severe inflammation of the eyes sometimes follows measles; but blindness from this cause is rare. Diphtheritic sore throat is not infrequent, and may be fatal in children. Chronic bronchitis is common, especially when care is not taken during convalescence to avoid exposure. Phthisis, under the same circumstances, is to be apprehended only where the constitution suffers under a predisposition to tubercular disease.

CAUSATION.—Measles is one of the most contagious of diseases, beyond all doubt. A second attack is exceptional, but not very rare.[1]

[1] Not long since, Dr. Salisbury, of Ohio, produced measles-like symptoms in several persons by exposing them to the influence of fungi growing upon damp straw. The identity of the affection with measles is not, however, probable. Drs. Hammond and Woodward, at Washington, repeated the same experiment without result.

Treatment.—Beginning with a moderately active saline cathartic, diaphoretics, expectorants, and demulcents are next in place. Syrup of ipecacuanha with neutral mixture ($\frac{1}{4}$ drachm of the former, for an adult, with each tablespoonful of the latter) every two, three, or four hours, would be an average treatment for the first week; flaxseed lemonade being freely used as a drink. After that, the continuance or relief of the bronchial symptoms must determine whether some other expectorant (as squills or wild cherry) shall follow. Or, debility may require tonics during convalescence.

Mumps.

Synonyms.—*Parotitis contagiosa; Cynanche parotidea.*

Symptoms and Course.—This is generally a mild affection, of a few days' duration. The parotid gland swells and becomes hot, painful, and tender to the touch. Some inconvenience in swallowing may result. There is little or no fever, but some general malaise; and the attack is generally at an end within a week. One or both parotids may be affected. There seems to be reason to believe that attacks may occur at considerable intervals, even of years, involving first one gland and afterwards the other. Suppuration is rare. This disease is undoubtedly contagious.

Diagnosis.—As the parotid gland, as well as other glands about the neck, may inflame from cold, salivation, or scrofula, it becomes sometimes a question whether a swelling in that region be mumps or not. When the parotid alone is affected, it is impossible to decide, unless direct exposure to another case of mumps be known. The parotid is, however, not apt to inflame under other causation, even from salivation by mercury; the submaxillary glands being much more liable to swell from that cause. The suddenness of the attack, and its brief duration, are generally also quite diagnostic of mumps, as compared with scrofulous or other inflammations of glands about the neck.

Complications.—*Metastasis* of mumps, to the mamma or testicle, or, more rarely, even to the brain, may occur. In either of the first two cases a somewhat similar inflammation of the gland attacked takes place; usually more protracted than that of the parotid. If the brain be the seat of the transfer of the morbid element or action, meningitis, or coma, may follow; and even death is said thus to have resulted. Otherwise, mumps are free from danger to life.

Treatment.—Care to avoid being chilled, lest metastasis or greater severity of the attack be produced, is important. No general treatment is apt to be necessary, nor does the patient usually need to remain in bed. Perhaps a mild laxative may be given on the first or second day. A poultice of flaxseed meal is a good local application for the gland. It may also be bathed night and morning with soap or volatile liniment.

Hooping-cough.

Synonym.—*Pertussis.*

Symptoms and Course.—After an incubation of about six days, with symptoms much like those of acute bronchitis, including fever of variable degree, the attack commences · soon showing its

peculiar character. This is, a spasmodic and paroxysmal cough. For hours, the patient may be apparently well; and then, often with a premonitory sensation which leads the child to run to its mother or nurse, or, if at night, to sit up in bed, a fit of coughing begins, and lasts for several seconds or minutes. It consists of a rapid succession of short but violent expiratory efforts, with scarcely any intervals of inspiration; at the close of which air is taken in by force through the contracted glottis, making a whooping sound, whence the name of the disease. All who have it do not whoop; but the *paroxysmal* character of the cough is pathognomonic.

Expectoration is often copious, of thick mucus, sometimes even of lymph and pus. Vomiting frequently occurs during the spells of coughing. The child may become very much exhausted, even to a fatal end; but unless from complication or previously feeble constitution, death does not very often occur. There may be many variations of severity in all the symptoms in the course of an attack.

The *duration* of hooping-cough is seldom less than six weeks, although cases have ended within three weeks. Sometimes it lingers for three or four months.

COMPLICATIONS.—Pneumonia, collapse of the lungs, and (as a sequela) phthisis, are the most liable to occur. Deafness from rupture of the membrana tympani during the violent coughing, has been known. Sometimes the eyes become blood-shot from the same cause. Convulsions occasionally increase greatly the seriousness of the disorder.

CAUSATION AND PATHOLOGY.—There is no question of the contagiousness of hooping-cough. Generally it occurs but once in the same person; but second attacks are not very rare. Like scarlet fever, measles, etc., it is most often met with in children; but this is merely from their susceptibility under exposure; as adults also have it.

Belonging among the zymotic diseases caused by a specific morbid poison, the spasmodic nature of the cough points to the nervous system as in main part the seat of its action. Yet the expectoration, as well as early (and occasional, afterwards) febrile symptoms, show that bronchial inflammation exists, secondarily at least.

TREATMENT.—Mild cases need only care to avoid exposure to damp and cold. After the first few days, if there be no fever nor soreness of the chest, the patient need not be kept in the house during good weather. Indeed, he will cough least when most out of doors. When the cough, at first, is tight and painful, with little expectoration, syrup of ipecac, or squills, may be given. As soon as the spasmodic character of the cough declares itself, with some violence, the "milk" or the tincture of assafœtida may be given; with or without other expectorants according to the case. Severe cases may be quieted by belladonna, hyoscyamus, musk, or hydrate of chloral. Hydrocyanic acid, bromide of ammonium (from two to twelve grains at once for a child), nitric acid, alum, clover tea, chestnut-leaf tea, and benzoic acid are among the other remedies often employed to allay the violence of the paroxysms. Application of strong solution of nitrate of silver to the larynx has some advocates.

In protracted cases counter-irritation to the chest and back of the neck may be required. *Tonics* are also not unfrequently called for toward the end of the attack in a feeble child; especially quinine, or tincture of bark (Huxham's), iron, or cod-liver oil. There is very seldom need to restrict the diet in this disease, unless during the first week.

Diphtheria.

SYNONYMS.—*Pseudo-membranous Angina; Putrid Sore Throat; Diphtheritis.*

HISTORY.—Though the name diphtheria (from διφθέρα, a skin or membrane) was only given to this disease by Bretonneau of Tours about forty years ago, it appears to have been described by early writers.

Late epidemics of it have been, principally, those of Paris and Boulogne of 1855–7, passing to England in the latter year; and of our own country beginning in California in 1856, and in the Eastern States a little later, gradually increasing in prevalence until 1860. Since that time it has declined in frequency, although still existing, and sometimes attended by great local fatality.

VARIETIES.—1. Simple; 2. Croupous; 3. Ulcerative; 4. Malignant diphtheria.

SYMPTOMS.—Premonitory, but not distinctive, are general *malaise*, slight sore throat, and swelling of the lymphatic glands behind the jaw. Then, in the *simple* form, fever occurs; with headache, furred tongue, constipation, and difficulty of swallowing. On examination, a swollen and very red or purple appearance of the fauces will be observed, as well as of the palate and tonsils. Over one or both of the latter may be seen, often as early as the second or third day, a whitish or yellowish-white membranous deposit. All the symptoms continue, in this form, from five to nine days; when, in favorable cases, convalescence follows.

The *croupous* form has caused the greatest number of deaths, especially in children. This seems especially prone to follow measles or scarlatina. In it, after the same early symptoms as those above described, but sometimes with violence from the beginning, increase of discomfort in the throat is complained of. Then an abundant yellow or brownish leathery exudation is found to cover the tonsils and fauces; which, under the exudation, are much swollen. Often quite early in the attack, the pseudo-membranous inflammation extends to the larynx. This is shown by the usual symptoms of croup; the barking cough and voice, and difficult inspiration, becoming whistling or sibilant when the obstruction to breathing is the greatest. A fatal termination may occur, by asphyxia, in a very few days. This can only be averted by the detachment and expulsion of the membrane, without its re-formation.

The *ulcerative* variety is not common. When destruction of the palate and tonsils has attended it, with copious dark-colored and pulpy exudation, and some extravasation of blood, it has been mistaken for, and described as, gangrene; whence the old name, "putrid sore throat." The occasional existence of true gangrene cannot be altogether denied.

Malignant Diphtheria.—At the commencement of this, there is, with intense headache, not unfrequently *vomiting*, which is uncommon in the milder varieties, and hemorrhage from the nose, mouth, stomach, or rectum. Great dysphagia soon exists, and enormous engorgement of the submaxillary, parotid, and cervical glands. The tonsils, pharynx, and palate are covered thickly with a leathery deposit, at first yellowish, but soon becoming ash-colored, brown, or almost black, and of an offensive odor. The tonsils may suppurate or even slough. The nostrils are sometimes involved; being swollen, lined with false membrane, and emitting an acrid and fetid discharge. Extreme prostration comes on, at a more or less early period; it may be from the first day. The pulse becomes very rapid, the face lividly pale, morbid heat of the skin being followed by clammy coldness. Coma often precedes death. The latter may take place in three, four, or five, occasionally in one or two days; sometimes from the constitutional impression of the disorder, before the local affection has been fully developed.

SPECIAL SYMPTOMS AND COMPLICATIONS.—*Albuminuria* is present in most severe cases of diphtheria, from an early time in the attack. A diphtheritic affection of the *skin* has been now and then observed. A blistered or otherwise abraded surface will usually, in the course of the disease, be covered by false membrane. *Pneumonia* is an occasional and dangerous complication.

SEQUELÆ.—These are, especially, long-continued debility, paralysis of the soft palate, and general paralysis in various degrees. In the last of these, deglutition, articulation, vision, and locomotion may be involved. A fatal result may occur after a few weeks, or recovery after a longer period; sometimes after from two to eight months.

MORBID ANATOMY.—The pellicle or deposit, formed upon the highly injected and tumefied mucous membrane of the fauces and throat, constitutes the anatomical peculiarity of the disease. Minutely examined, the false membrane is found to vary from $\frac{1}{20}$ to $\frac{1}{8}$ of an inch in thickness, and to be fibro-laminated; *i. e.*, of layers of fibrinous network, including epithelial cells, and having on its free surface exudation-corpuscles or "pyoid globules," and granules; these forms appearing to be only stages of degeneration.

No process of organization or development occurs in the mass; it is aplastic. In some cases only a granular superficial infiltration of the mucous membrane is observed, without even distinct fibrillation.

DIAGNOSIS.—From *scarlatina*, diphtheria is distinguished by the absence of the eruption, and of the peculiar punctated or brick-dust like flush of the throat, and "strawberry tongue." That scarlet fever *predisposes* to diphtheria, as a subsequent attack, is a well-established and not unimportant fact.

With *membranous croup*, it is contrasted in the following manner. That disease is a sporadic and sthenic local phlegmasia, whose general symptoms are, as much as in any inflammation, dependent upon the local affection; while diphtheria is a constitutional disorder, usually epidemic, in which the local symptoms are secondary. More directly, in practice, we may mark the commencement of the pseudo-membranous deposit, in diphtheria, about

the tonsils and pharynx; in croup, in the trachea or larynx. That of diphtheria rarely extends, in any case, below the larynx; that of croup, not unfrequently even into the bronchial tubes. After laryngeal complication or extension has occurred in diphtheria, the croupal symptoms are really the same as those of any other laryngeal obstruction, and thus are not different from those of croup. Several excellent authorities assert that *all* cases of membranous croup are really cases of diphtheria, involving the larynx.

From *thrush*, and *aphthæ*, diphtheria is known by the deposit being much larger and thicker, never vesicular, and mostly duller in color; and attended generally by more severe constitutional symptoms. Thrush begins in the mouth; it is, moreover, much more uncommon in adults than diphtheria; and is never epidemic.

PROGNOSIS.—*Simple* diphtheria is not very dangerous to life. The croupal form is decidedly so; and the malignant is fatal in a large majority of cases. *Insidiousness* is a trait often belonging to the disease in children; a name which has been applied by some, for that reason, is "creeping croup."

TREATMENT.—No specific remedy having been discovered for this disease, we must be governed in our tentative treatment of it by our idea of its nature; while concluding upon its therapeutics, finally, through experience. Nothing, it may be confessed, is very satisfactory, as yet, in the management of bad cases of it. All agree that it is not a mere local inflammation, but a systemic affection primarily; and that its type is most generally asthenic. Moderate purgation, as with citrate of magnesium, or Rochelle salt, at the very beginning, is well in the simple and croupal, though not in the malignant form.

Chlorate of potassium is a favorite medicine with many in this disease. An adult may take twenty grains in solution every three hours; I have given five grains every two hours to a child five or six years old.

Tincture of chloride of iron is relied upon by some; from ten to twenty drops every three hours for an adult; with or without the chlorate of potassium. Sulphate of quinine is also given, alone, or at the same time with the above remedies, by a number of practitioners; say, of quinine, for an adult, a grain every two or three hours.

Besides these, or instead of them, for internal use, permanganate of potassium has, after trial, the recommendation of some observers. A drachm of it may be dissolved in a pint and a half of water, a fluidrachm of this being taken every hour. Sulphite of sodium, ten grains every two or three hours, is worthy of trial in this, as in other zymotic diseases.

Concentrated liquid food must, as a rule, be given throughout an attack of diphtheria; milk, beef-tea, and very often wine whey or brandy or whiskey punch; in small quantities at short intervals, according to the degree of prostration present.

Local treatment is, by most physicians, regarded as very important. Experience has shown that it ought not to be violent. Ice in small pieces melted in the mouth slowly, is probably as useful as any application. Muriatic acid and honey, equal parts, applied freely with a large camel's hair pencil; or diluted with

water and used as a gargle, may be found serviceable. Creasote dissolved in glycerin; lime-water; chlorinated soda dissolved in twenty parts of water; and permanganate of potassium, a drachm in a pint, make also appropriate gargles. In a young child ice is often the only local application possible without a struggle so disturbing as to make the benefit of it doubtful. Cold water compresses may be applied outside of throat in the early stage, while there is excess of heat. Later, flannel wrung out of hot water to which an equal amount of spirits or vinegar has been added, will give more comfort.

Inhalation of the steam of lime-water is worthy of trial in diphtheria, especially in the croupous variety; or, the *atomization* of lime-water by the *nephogene* or some other apparatus constructed for the purpose.

But the local treatment is, after all, secondary. And especially is the effort to remove the patches of exudation by force, as by excision or actual cauterization, to be deprecated, as likely to do harm rather than good.

Influenza.

SYNONYM.—*Epidemic Catarrh.*

HISTORY.—Although, among many persons exposed to the same weather, catarrhal affections are of course common at certain times, there is evidence that, apart from the conditions of humidity and temperature of the air, *epidemic catarrh* sometimes occurs as a zymotic disease. The local prevalence of influenza may exist at very irregular periods, and sometimes so mildly as not to be distinguished from common sporadic catarrh.

SYMPTOMS AND COURSE.—The ordinary symptoms of a "bad cold" are those of influenza; but the illness is somewhat more severe, and prostration is generally greater. Of this there are all grades, however. Bronchitis, sometimes capillary, and pneumonia, are not rare complications. Old people are especially apt to be carried off by influenza. Its mortality is very small among persons in early or middle life. The *duration* of an attack is commonly from three to ten days.

CAUSATION.—The hypothesis has been entertained, in consequence of the irritating effect of ozone upon the air-passages, that an excess of it in the atmosphere may be the cause of influenza. But no facts raise this supposition beyond conjecture.

TREATMENT.—Mild cases require housing and little more. A warm mustard foot-bath at night, followed by a large draught of hot lemonade if there be chilliness, or the same taken cold if fever exist—and a dose of solution of citrate of magnesium or Rochelle salt or senna tea in the morning, will generally suffice. Sweet spirit of nitre may be added to the night draught if the skin be dry and the urine scanty.

Great prostration, especially in old people, may call for support, by quinine and stimulants. Hot whiskey punch is, for such a case, not out of place. The *abortion* of an attack of influenza is sometimes practicable within the first two days, by giving quinine, in four-grain doses, thrice daily. Bronchitis or pneumonia, as complications, will require treatment as in other cases.

Dengue.

Synonym.—*Break-bone Fever.*

History.—Frequently in the Southern United States, occasionally in the Northern (at least Dr. Rush seems to have described it at Philadelphia in 1780), and in the East and West Indies, this disorder has occurred. English writers regard it as a variety of scarlet fever; naming it *Scarlatina rheumatica.*

Symptoms and Course.—Usually after a chill, fever comes on, moderate in degree, but attended by considerable debility, and severe pains in the head, back, and joints; the latter being somewhat swollen. In about two days or less, the fever subsides, and the pains lessen, though they do not disappear. Toward the end of a week from the commencement of the attack, a rash breaks out, resembling that of scarlatina, or duller and more in patches. The fever returns, often, about the fourth or fifth day, and lessens or ceases after the eruption has come out. All the symptoms gradually subside, leaving the patient well but very weak, by the beginning or middle of the second week of the attack. This disease, without complication, is never fatal; nor does it leave any sequela except debility.

Its causation is not known, beyond what is comprised under the term "epidemic influence." It is noticeable that it affects more persons at one place and time than almost any other epidemic; nearly all the population may have it in one season; all ages and both sexes being alike attacked.

In treatment, dengue requires merely good nursing—regulating the bowels, and relieving or mitigating the pains with Dover's powder or other opiates, especially at night, or by the local application of laudanum, etc.

Malarial Fever.

Varieties.—*Intermittent*, *Remittent*, and *Pernicious* Fever. These may all be properly regarded as grades or modifications of the same type of disease; agreeing in the nature of their cause, the periodicity of their symptoms, and their mutual convertibility. Each will, however, require a separate description.

Intermittent Fever.

Synonyms.—*Ague; Chills and Fever.*

Varieties.—*Quotidian*, when the paroxysm occurs every day; *tertian*, when it is every other day; *quartan*, on the first and fourth days; also, *quintan*, *sextan*, *septan*, and *octan*. The quotidian and tertian are common; the octan, or weekly return of the attack, is not unfrequently met with; the others are very rare. The time between two paroxysms is called the *intermission* (apyrexia); the period from the beginning of one chill to the beginning of the next is the *interval.* Paroxysms are sometimes *double;* as, double quotidian, with two paroxysms on one day; double tertian, with a paroxysm every day, but those of every other day corresponding in time or character, etc. These are rare.

Symptoms and Stages.—No disease has ordinarily so regular

a succession of definite stages as intermittent fever; viz., the *cold*, the *hot*, and the *sweating* stage.

Cold Stage, or Chill.—Beginning with languor and yawning, a sensation of coldness comes on, often creeping and shivering, with chattering of the teeth and *rigors* or tremulous movements. The skin has a sunken appearance, and the lips and finger-ends may be blue. The *sense* of coldness does not prove a low temperature of the body; which the thermometer sometimes shows to be even hotter than natural. Thirst exists, with loss of appetite; occasionally, vomiting. Headache, depression of spirits, and drowsiness are common. Perspiration is absent, but the urine is abundant and nearly colorless, with a low specific gravity. The duration of a chill varies from ten minutes to two or three hours; averaging not more than three-quarters of an hour.

Hot Stage; Pyrexia.—Gradually warmth is felt to return; the shivering ceases; a flush succeeds the pallor or lividness of the face. A real increase of the heat of the surface is found by the thermometer; reaching 105° to 110°; seldom more than 106°. The mouth becomes dry, the tongue furred; vomiting is common, with total anorexia. Headache is apt to be violent; but delirium is rather exceptional. The pulse is accelerated, and generally strong and full. The bowels are constipated; the skin dry, the urine scanty and high-colored. The hot stage may last from an hour or two to sixteen or eighteen hours.

Sweating Stage.—This also comes on gradually; the face first becoming moist; then the trunk and limbs. This is attended by increased comfort; the headache lessens, the stomach if disturbed becomes quiet, the patient often goes to sleep and sweats profusely all over. After this, the fever has gone; the pulse is slow and soft, the skin cool. The urine is now passed freely, and deposits a brickdust-like (lateritious) sediment. There is no definite length of time to be assigned to the sweating stage.

Of the three stages, now and then one or two may be wanting. There is then only a chill, or a fever, or a sweat, occurring daily, or every other day, at the same hour. Or, a paroxysm of pain may occur in one part of the body, with the same regularity. One form of this is called "brow ague." *Dumb* ague is a popular name for an attack in which the chill is absent or obscure, the other symptoms recurring periodically. There seems to be no doubt that a single limb, or even a single finger, may go through all the three stages—cold, hot, and sweating; the rest of the body being unaffected. Intermittent *neuralgia* is very common in malarial districts, especially after chills and fever. In the same regions, *all* complaints are apt to take on periodicity; so we may have intermittent dysentery, pneumonia, etc.

The *intermission* is often a time of apparent health, except some debility, and perhaps headache with want of appetite and of good digestion.

The greater number of paroxysms of intermittent occur in the daytime. An attack which began as a tertian, may become a quotidian; or the converse may happen. Intermittent sometimes passes into remittent fever; though much less often than remittent becomes intermittent.

SEQUELÆ.—Protracted intermittents are often accompanied or followed by anæmia, of a marked character, and by enlargement of the spleen and liver; especially of the former. Dropsy is a quite frequent result of these visceral affections or of the anæmia.

MORBID ANATOMY.—*Melanæmia*, or pigmentary degeneration of the blood-corpuscles, with deposit of pigment granules in the liver, spleen, kidneys, brain, etc., is almost a characteristic of malarial disease. Enlargement and softening of the spleen, and engorgement of the liver, with a bronzed appearance of it, are the only other peculiar changes of structure.

DIAGNOSIS.—*One* chill can hardly ever be certainly pronounced to be malarial, because very many acute disorders begin with a cold stage. Two, with a distinct apyrexia, cannot often be confounded with anything else, except hectic fever. In the latter, there is usually a known *cause* for the symptomatic febrile symptoms; the patient is weak and emaciated, the paroxysm is irregular in time and duration, there is a bright roseate flush upon the cheek, and headache is usually absent.

PROGNOSIS.—Left to itself, intermittent will sometimes get well as early as the seventh, eighth, or ninth paroxysm; more often it will last ten weeks; sometimes as many or more months.

Under treatment, it is almost always possible to *break* the chills by cinchonization; but they frequently return; especially at the end of one, two, or three weeks. It is a good sign for the paroxysm to occur later and later in the day, and to become shorter and shorter. Tertian ague is generally the most readily cured; quartan the most intractable, though comparatively uncommon. Death, in modern times, since the discovery of the properties of Peruvian bark, almost never happens from the ordinary type of intermittent; the *pernicious* form is very dangerous.

CAUSATION.—Upon the origin of malarial fevers, the following facts seem to be established:—

1. They are reasonably designated as *autumnal* fevers, because very much the largest number of cases occur in the fall of the year. Spring has the next greatest number of cases.
2. They are always strictly localized in prevalence.
3. They never prevail in the thickly built portions of cities.
4. An average summer heat of at least 60° for two months is necessary to their development. Their violence and mortality are greatest, however, in tropical and sub-tropical climates.
5. They prevail least where the surface of the earth is rocky; and most near marshes, shallow lakes and slow streams. The vicinity of the sea is free from them, unless marshes lie near it.
6. The draining of dams or ponds, and the first culture of new soil, often originate them.
7. Their local prevalence in the autumn is always checked by a decided frost.

Upon these facts, it was a legitimate hypothesis (urged especially by the late Professor J. K. Mitchell of Philadelphia) that the material cause of malarial fevers is a minute vegetative organism, whose substance or emanations enter the body. Professor Hannon of Brussels relates that he learned in 1843 from Professor C. Morsen,

and verified the statement in his own person, that the exhalations of certain fresh-water algæ would produce ague.

Dr. Salisbury, of Ohio, has recorded in the January number of the *American Journal of Medical Sciences* for 1866, some observations and experiments, tending to show that minute cryptogamic plants of the family of Palmellæ, abounding over the surface of marshes, can generate intermittent fever, when transported to localities otherwise free from it. Such results require of course repeated investigation to make them actually matters of demonstration.

TREATMENT.—One remedy in this disease overshadows all others—*cinchonism.* By this we mean, the production of the constitutional impression of the cinchona bark, or of one of its essential constituents. At any stage it appears to be safe unless it be the very height of the pyrexia. Nor, as a rule, is any special preparation necessary.

It is well, always, during the chill, to promote speedy reaction by external warmth, and perhaps by hot drinks, of a not too stimulating character. The bowels ought to be opened well; and the stage of fever may be palliated by the free drinking of cold water, made more diaphoretic by the addition, if necessary, of neutral mixture or effervescing draught. Then, as soon as sweating fairly begins, the quinia, or cinchonia, or bark in substance may be prescribed.

The sulphate of quinine has the most universal reliance. Some give it in doses of several grains, each twice daily. Others prefer to give one grain every hour. The amount required in the intermission of ordinary intermittent is about fifteen grains. Less may often cure, but can hardly be depended on. The quinine may be given in pill or in solution. Direct that, in tertian ague, the patient begin early on the day of the intermission, and take one grain every hour till he has taken twelve grains. The next day let him begin at the same rate, and, if no chill occur, take ten grains. The third day nine; and so diminishing daily until six grains are reached. Let this be continued till a week from the last chill, when a greater tendency to return will exist; on that day let ten grains again be given. After that time, if no paroxysm has occurred, he is, for the time at least, well.

Sulphate of cinchonia, in doses one-half greater (gr. jss instead of one grain) has succeeded in a considerable number of cases. It generally produces much less ringing in the ears than quinine, and can be taken by some whose heads do not bear that medicine. Bark in substance, especially Calisaya bark (an ounce in the intermission), is of course perfectly reliable; but it is disagreeable and oppressive to the stomach, and should only be used when its derivatives cannot be obtained.

Other remedies in considerable number have obtained more or less reputation in the treatment of ague. Opium, given in full dose (say 60 drops of laudanum) shortly before the time of an expected chill, has been found generally to abort it. Arsenic (10 drops of Fowler's solution thrice daily) is considered to approach very nearly in certainty to the preparations from cinchona. Sulphate of copper is asserted by some (in $\frac{1}{4}$ grain doses) to be antiperiodic;

and so is nitric acid (10 drops thrice daily, diluted); and common salt (a drachm at a dose, half an ounce during an intermission). Dogwood bark; pepper, and its extractive, piperin; willow bark, and salicin obtained from it, have also some reputation of the same kind. Chloroform, taken by the mouth, has been used with success by Dr. Merrill. He gives f℥j at once, at the beginning of the chill. It may be diluted with mucilage. A strong impression of almost any kind upon the system during the apyrexia, may arrest or prevent the paroxysm. So may act the drawing of a blister upon the spine; or a cold shower-bath.

But the *breaking* or interruption of chills, though generally curative of a first attack, is not nearly always so in a second or third.

Chronic intermittent may maintain a constant tendency to relapse, in spite of cinchonism. In such a case, *anæmia* and the malarial cachexia are usually present. Here the great remedy is *iron*. Give the carbonate, Valleix's mass; with a grain of quinine in each pill, continuing it for several weeks.

Remittent Fever.

SYNONYM.—*Bilious Fever.*

VARIETIES.—Simple and malignant. The latter, however, will be described under *Pernicious Fever.*

SYMPTOMS AND COURSE.—Although the premonitory stage is usually short, and not unfrequently wanting, its general occurrence is well established. Its symptoms are those of general *malaise*, with some headache, slight nausea, and furred tongue. These increase, until a chill, not violent, but lasting sometimes half an hour or an hour, fairly begins the attack. Or, an ill-defined cold stage, with a feeling of chilliness, languor, and debility, and perhaps cerebral oppression and gastric disorder, may occur.

After this, the febrile condition is developed. The skin becomes hot, dry, and harsh; the *pulse* rises in force and frequency, although less hard and tense than in some diseases, and not exceeding generally, during the first exacerbation, 110 or 115 beats in the minute. The face is flushed; *headache* is throbbing and severe; the faculties being unfitted for any mental exercise. *Violent pain* is almost always felt in the back, and very often also in the limbs. *Epigastric uneasiness* is nearly universal; nausea and vomiting extremely common. Bilious matter is in many instances ejected from the stomach. The *bowels* are costive; when opened, however, the stools are colored with bile. The *urinary* secretion is scanty. *Thirst* is always great; cold drinks being much preferred. *Respiration* is hurried, although free.

After a continuance of from eight to twenty hours, these symptoms abate more or less, even without treatment. The feelings of the patient are more comfortable; he sleeps; and wakes with a skin less hot, and moist, perhaps even with considerable perspiration. Headache, however, and some pain in the back remain; and the pulse does not subside to the natural standard. In some instances it is little altered. The stomach, however, is less disturbed, and thirst is somewhat less intense.

There is reason to believe that a few cases of genuine malarial

remittent may, by prompt treatment during the hot stage, be quelled, so as not to advance beyond the first exacerbation and remission. We ascribe their facility in yielding, chiefly, to a less degree of intensity in the morbific cause.

Mostly, in from six to twenty-four hours, the patient's discomfort again increases; the skin becoming even hotter than before, and quite dry; the pulse rises to 120 in the minute; thirst is great, although sometimes less than in the first paroxysm; the headache returns, and with it usually severe pain in the back. The tongue is now thickly furred, often with a yellowish hue. Nausea and disgust for food are again felt, and in a large number of cases vomiting returns; the stomach rejecting everything, even cold water. The stools, when obtained, are sometimes slate-colored; but more often decidedly colored with bile. Diarrhœa is uncommon, and is most apt to accompany a later stage. *Delirium* is common only in violent cases; restlessness is almost universal. *Yellowness* of the skin appears in a majority, in various degrees.

The advance of the disease, after the second paroxysm, is exceedingly various. The periodical character, however, is maintained throughout. The remissions may occur at any hour—in moderate cases being as often in the afternoon as in the morning; in the protracted more commonly in the morning, the fever lasting through the night. Quite frequently a *double tertian* type is observed; the exacerbation occurring one day in the morning, and the next in the afternoon; and sometimes with different degrees of violence.

Duration.—Favorable cases often terminate in six or seven days in an intermission, which in some becomes a cure even without any anti-periodic treatment. The more violent, especially if ill-managed or in an abnormal constitution, may be protracted for three, four, or occasionally five or six weeks. We should distinguish, however, between the true periodical disease and its *sequelæ*. The average duration of a case of remittent fever may be stated as about fourteen days.

Complications.—These are usually dependent on *local inflammations*. The *brain* is perhaps the organ most frequently affected, with cerebritis or meningitis. In late autumn, or other cool weather, *pneumonia* is not uncommon. *Gastritis* and *enteritis*—diarrhœa and dysentery of an obstinate character sometimes occur. When any of these affections exist, they partake to some extent of the periodical character of the fever; and are often lessened or removed by the treatment adapted to it. In other cases, however, they remain in a subacute or chronic form; and, when death occurs, in a majority of instances the immediate cause is a violent phlegmasia of some organ. *Hepatitis* and *splenitis* are more common in the chronic form than in the acute—and as sequelæ rather than complications of the attack.

The Typhoid State.—At any time after the fourth or fifth day, but particularly near the end of the second week, a patient suffering with remittent fever may pass into the condition designated by the above term. Its features vary somewhat; but it is usually marked as follows: Pulse 120 to 140, and rather deficient in

strength; skin harsh, varying, however, with the slight remissions in dryness and temperature; face dark or flushed; head hot; delirium, active more frequently than comatose; bowels occasionally affected with diarrhœa, but as often costive; tongue heavily coated with sordes, brown or black, and with cracks or fissures across it. Muscular debility is usually great. Hemorrhages from the bowels, lungs, or stomach occasionally increase the danger.

Where death occurs within the first three weeks, it is almost always the result of some inflammatory complication. Remittent fever rarely proceeds to a fatal termination by mere exhaustion of the powers of nature. In feeble or aged persons, however, this may occur.

SEQUELÆ.—A slow and imperfect convalescence not unfrequently follows a violent attack; attended with sallowness of the skin, feeble digestion, muscular and nervous debility. The only organic alterations at all constant are enlargements of the liver and spleen.

MORBID ANATOMY.—The most striking observation upon this was that made at the Pennsylvania Hospital by Dr. T. Stewardson, in 1841, of the unusual color of the liver; bronzed without and olive-green within. Subsequent confirmation of this has been afforded; although Dr. Drake, of Cincinnati, failed to find it in his autopsies. The spleen is almost always enlarged, congested, and softened. Inflammation of different organs (making fatal complications), especially the brain, lungs, or bowels, may exhibit the usual results. Such lesions, however, are sometimes absent in the most malignant cases. Pigment-liver has been referred to already.

CAUSATION.—This has been considered under the head of intermittent fever.

DIAGNOSIS.—Yellow fever has by some physicians been regarded as identical with remittent, differing mainly in the grade of its violence. The correct view is, that they are specifically distinct diseases. To prove this, we might be satisfied with the simple fact of the different localization of the two fevers. Remittent is always a country fever; yellow fever almost invariably a disease of towns and the vicinity of the sea. The latter is restricted much more narrowly, also, in its actual geographical limits.

But there are symptomatic differences also; which may be best pointed out after giving a description of yellow fever. Among the important points, one is, that an attack of the latter disease commonly gives immunity from it for life; but this is not at all the case with remittent fever.

When the typhoid state supervenes, there may exist very considerable similarity to the true typhoid fever. It is asserted that a coexistence of the two diseases occurs. Some, upon the same facts, ground the opinion that they are not specifically different; —but that *typhoid fever is merely* a protracted remittent of low form. This is however contradicted clearly by at least two facts; 1, the comparative rarity of typhoid fever in regions where remittent most abounds; and 2, the frequent prevalence of the typhoid

where remittent fever is almost unknown; as in some of the Eastern States.

The mode of onset in the two, moreover, is usually quite different; in typhoid, insidious and almost imperceptible at first; in bilious fever, after a day or two of malaise, a chill abruptly ushers in the attack. Vomiting is extremely common in the one—quite rare in the other; the converse is true of diarrhœa—and still more particularly of tympanites and abdominal tenderness. The *deafness*, and *sleeping* stupor—and *livid* countenance of typhoid fever, are almost entirely peculiar. Epistaxis, bronchitis, and the rose-colored eruption, so nearly constant in the latter, are rare in the typhoid remittent; the last mentioned is perhaps never observed. The yellowness of the skin, also, and the *distinct* remissions, mark well the remittent attack. In dissection, we find more *gastric* and *hepatic* change after bilious fever, and more *enteric* and *splenic* alteration in the typhoid.

Prognosis.—Recovery may be anticipated in a majority of instances. Before the use of cinchona, remittent was often quite fatal.

Favorable signs are, the earlier occurrence and prolongation of the remission, and its becoming more and more complete; moistening and clearing of the tongue; copious perspiration; turbidness of the urine, from increase in the amount of its solids; tar-like and offensive stools; and the appearance of vesicles about the lips.

Unfavorable, of course, are, the shortening and postponement of the remission, and its indistinctness; dryness, and blackness of the tongue; retention, or, still worse, suppression of urine; extreme frequency, with weakness, of the pulse; hiccough; and other important evidences of the victory of disease over the vital functions—not, however, peculiar to the fatal termination of this disease. The supervention of the usual symptoms of *inflammation of the brain* is always very alarming; *gastritis* may occasionally threaten to wear out the patient's strength; and *pneumonia* is attended with more danger when occurring as a complication of fever, than when an original disease.

Treatment.—In a person of robust constitution, if the headache be very severe, skin hot, and pulse full as well as rapid, it is common to administer a saline cathartic. Epsom salts will be the best when the *stomach* is but little disturbed—the Seidlitz powders in repeated doses under contrary circumstances may answer. But some commence the treatment with a dose of calomel or blue pill with rhubarb, to be *followed* by a saline purge. If obstinate vomiting prevail, as will frequently happen, no purgative will suit so admirably as the effervescing solution of the *citrate of magnesium*. The utility in many cases of *leeches or cups* to the nucha, and sometimes to the epigastrium, is undoubted.

As a refrigerant diaphoretic, the citrate of potassium solution, with or without effervescence, may be constantly given.

Special treatment may often be called for by the great intractability and distress of stomach. Lime-water or *magnesia* in small doses with *ammonia* and an aromatic will frequently relieve.

Sinapisms and pediluvia are of course useful adjuvants. *Ice* will

answer better to quench thirst than water, where gastric irritability is great; otherwise free dilution by drink is an advantage.

As soon as the violence of systemic excitement has been moderated—without waiting for its entire subjugation—if the pulse has *begun to subside*—lowering, for instance, from 110 or 120 to 90 or 100, and the headache is less intense—*the bowels freely moved*—we may begin with quinine; but it is unnecessary *here* to give large doses generally. Unless where some malignancy is suspected, or the remission is very complete, *a single grain every two hours* will be sufficient at first. Under this, after reducing measures, we may find the pulse continue to subside—the skin to moisten, and all the symptoms to improve. At all events, in the next remission, the dose should be increased to *a grain every* hour—not, as a general rule, however, awaking the patient from sleep. Two grains every hour for eighteen hours, is the freest administration ever necessary in a case even threatening malignancy. This term, it need hardly be said, is used to express the existence of a state of prostration, attended with signs of visceral congestion, increasing dangerously with each paroxysm; reaction being deficient, as we believe, from an unusual intensity of the morbid cause—or defect of constitution. Such cases do require a large amount of the special remedy; and such cases are no doubt much more frequent in warmer Southern States than here. We have no difficulty in believing in the toleration, or even the propriety, of *considerably* larger doses than are here given; but there is a limit even there, to go beyond which is excess. Perhaps we should allow somewhat in the estimate in some remote places, for the immense *adulteration* of valuable drugs which prevails. Many practitioners in the Southern States insist, that no preparation whatever for the use of quinine is necessary; and that it may be given with safety and advantage throughout the hot stage of the fever.

After two or three days of constant "*quininization*," the amount, usually, may be diminished to six or eight grains, distributed through the day. In rather smaller quantities it should be continued even through the period of convalescence.

The treatment of inflammatory or other *complications* must of course superadd modifications appropriate to each. We have named, in the above sketch, all the *main elements* of the plan which is found successful in such cases as ordinarily occur.

The existence of local inflammations, in a genuine malarial case, does not contraindicate the use of quinine. Being lit up by the fever-poison—and aggravated by its febrile state, the treatment which annuls or removes these will often lower or check the phlegmasia. But this maxim should be applied with caution and some exceptions, in cases particularly of *cerebral inflammation*, or great pulmonic oppression.

In slow convalescence, with sallowness and deranged digestion, the daily administration for a few days of minute doses of blue mass generally proves useful. And, to improve sanguification, as well as to lessen the danger of relapse in some form, the *protocarbonate of iron*, in pill with a portion of sulphate of quinine, will make a very valuable termination of the treatment. Arsenic may sometimes be required.

Pernicious Fever.

SYNONYMS.—*Congestive Fever; Malignant Intermittent; Malignant Remittent.*

SYMPTOMS AND COURSE.—Unlike ordinary intermittent, a paroxysm of the pernicious form may commence either in the day or night. At first, however, in many cases, it begins like the common type of chills and fever, or remittent fever; after one, two, or three days becoming more alarming.

Then, the skin grows lividly pale, shrunken, and sometimes clammy with cold sweat; the countenance anxious; the tongue either pale, furred, or natural; in the worst cases it is cold. Thirst is intense, with a sense of internal heat. The stomach is excessively irritable, and vomiting is common, of mucus, or a muco-serous or even bloody fluid. The bowels are in most cases loose, the dejections resembling bloody water. The pulse is usually small, weak, and rapid or irregular; in a few instances corded. The respiration is interrupted and sighing, with a sense of oppression.

Restlessness is common; but the mental faculties in many cases are clear. There are, however, many instances in which the weight of the attack falls on the brain. Then, the early symptoms are drowsiness and hesitation of speech. Stupor marks the depth of the paroxysm. The breathing may be stertorous; or tetanic spasms may occur. The pulse, in the former case, may be slower than in the other form described; but it is still weak, and, even if the head be somewhat warm, the vessels of the neck and temples are not apt to be swollen, and the skin of the body is cold.

Partial, or, it may be, complete reaction in most instances follows after three or four hours of the above symptoms; though death may, instead, take place in the collapse. Again the fever may intermit, or remit;—and, at the same or an earlier hour the next day, another paroxysm occurs. This is more dangerous than the first. If a *third* be allowed to take place, it is generally fatal.

MORBID ANATOMY.—*Congestion*, of the brain, liver, spleen, and alimentary mucous membranes, is so prominent an autopsic phenomenon as, with the symptomatic appearances of the same, to have seemed to justify the older and more common name of the disease. We have good reason to believe, however, that the toxæmic impression of malaria, and its effects upon the nerve-centres (either of organic or of animal life), are primary, and the congestion secondary.

DIAGNOSIS.—The *intensity* of the symptoms, and the general prostration, or coma, will distinguish this from ordinary intermittent or remittent. The aspect of a severe case is not unlike that of an attack of epidemic cholera; but the discharges are different; and the locality and season, unless in the presence of that epidemic, will point directly to malarial causation.

PROGNOSIS.—Without appropriate treatment, a large majority of cases would be fatal. There are few diseases displaying a greater tendency to death. Under cinchonism, and other proper management, not more than one in eight probably die.

TREATMENT.—As above implied, quinine is our great reliance

in this disease. Larger doses are required, also, than in ordinary intermittent. While opinions differ, the best evidence shows that from thirty to sixty grains of quinine in twenty-four hours will do all that the remedy can do ; more will be wasteful and dangerous.

But, in *most* cases, other means must be employed, sometimes before quinine can be kept upon the stomach, to promote reaction. External stimulation is foremost among these means. Direct heat may be applied, by hot-water bottles or tins, hot bricks, or bags of hot salt laid along the spine, or by the hot bath. Thirst should at the same time be quenched by cold water, or, if the sense of heat is great, and vomiting occur, with ice. Mustard plasters may be placed upon the spine, epigastrium, or limbs ; or the extremities may be rubbed with brandy and red pepper.

The opposite of this plan is preferred by some, upon asserted favorable experience, viz., the pouring or dashing of cold water quickly upon the naked body. Extensive dry cupping along the spine is recommended by others.

Internal stimulation, also, is demanded under the same circumstances. Most used have been camphor, opium, ether, oil of turpentine, ammonia, and capsicum, besides wine and brandy or whiskey. The best testimony is in favor of camphor and opium, with quinine, in moderate doses every half hour during the chill, when no comatose symptoms are present. If these exist, oil of turpentine, by the mouth or rectum, has its decided advocates.

Calomel has been largely used in the same cases. Some give it, in the dose of a grain, every three hours.

Alcoholic stimulants seem to be indicated in the collapse. A tablespoonful of brandy or whiskey every half hour or hour until *reaction* occurs would be a suitable average.

After reaction has been established, even imperfectly, and an intermission or remission exists, the "sheet anchor" is quinine. Then if the stomach bear it, five to ten grains may be given every two or three hours, until cinchonism is fully established. When the quinine is rejected by the stomach, hypodermic injection may be resorted to. Ten grains or more may be introduced at once, in solution in water, with sulphuric acid enough to dissolve it perfectly.

In the *cerebral* cases, calomel is particularly appropriate. A blister to the nucha may be recommended in the same cases. Purgatives are also apt to be required ; and, if the heat of the head be great, iced water may be kept applied over it, while hot bottles or sinapisms are put to the legs or feet.

When the critical period in pernicious fever has passed, it will need treatment like an ordinary case of intermittent or remittent, according to the type which it assumes. A modification of this affection, sometimes called "winter fever" in the South, will be considered under the head of *typhoid pneumonia*.

Typho-Malarial Fever.

This, having had its origin in the circumstances of the late war, is now altogether a matter of history. It was the result of a threefold causation ; the elements of which were *malarial influence*, *crowd poison*, and *scorbutic taint*. According to the predominance

of one or the other of these, its character in different cases was determined. Of the form in which the *malarial* element predominated, the somewhat abrupt commencement, gastric disturbance, and icteroid skin and tongue, with remissions, for a while at least tolerably distinct, were prominent features. The lenticular spots of typhoid fever, and the sudamina and tympanites were often wanting altogether.

A slower onset, less distinct remissions, more cerebral disturbance and diarrhœa, with epistaxis and bronchitis sometimes, but with both less constantly than in civil life, marked the predominance of the *typhoid* pathogenetic element. Deafness was not very frequent, but was sometimes very well marked. The aspect of the countenance, and the character of the somnolence and delirium, were precisely the same as in ordinary typhoid fever.

The *scorbutic* complication was recognizable, in the third group of cases, by the peculiar mental and bodily prostration which preceded and followed the disease—the remarkable irritability of the heart, the state of the gums, tendency to hemorrhage, discolorations and petechiæ, pallid, large and smooth tongue, and extremely protracted convalescence.

TREATMENT.—From the above view of the hybrid and threefold nature of the disease, came its rational treatment. More *quinine* than in typhus, more *alcohol* than in remittent, more *fresh vegetable food* and fruit than in either. Experience justified this plan.

Yellow Fever.

Only certain localities have ever been subject to this disease; and of those, most have had it but occasionally.

All the places which it has ever visited are upon the borders of the Atlantic Ocean, or its tributary waters, the Gulf of Mexico and the Mediteranean Sea. Although under like climatic conditions, while it is common in the West Indies and West Africa, it is unknown in the East Indies, the eastern shore of Africa, and the Pacific coast of America.

SYMPTOMS AND COURSE.—With an abrupt beginning, or an indistinct cold stage, with pains in the back or limbs, commencing often in the night, a febrile stage occurs, of long average duration; sometimes three days without remission. Violent cases have it shorter; sometimes lasting only a few hours.

The skin, at this period, is hot and dry. Thirst is extreme; the tongue is generally furred. Nausea and vomiting are common on the second day, with great epigastric tenderness. The bowels are costive; if discharges occur they are very offensive.

A flush of the forehead, with a fiery look of the eyes, is characteristic. Delirium is frequently present. Violent headache is nearly universal.

The stage which follows this pyrexia is a sort of remission or intermission. All the symptoms abate except the epigastric tenderness. The flush of the face and of other portions of the skin is succeeded by yellowness, which grows deeper as the disease advances. The pulse grows slower, heat abates, respiration becomes natural in frequency, the patient sits up and feels better.

This state of things lasts for a variable time, averaging about twelve hours.

Sometimes convalescence now takes place. Much more often a third stage succeeds, of prostration or collapse. Muscular debility becomes great; the pulse is rapid, irregular, and compressible; the capillary circulation sluggish; the skin deep yellow or bronzed; the tongue brown; the stomach excessively irritable. It is at this time that the *black vomit* occurs, which is pathognomonic of this fever. Hemorrhages may also occur from the mouth, throat, or bowels. The mind grows apathetic, or low muttering delirium exists. In bad cases, which are many, hiccough, clammy sweats, convulsions, and involuntary discharges precede dissolution. Death most frequently occurs on the fourth, fifth, or sixth day.

When reaction from the collapse takes place, there follows a secondary fever of very variable duration, and which may terminate in a tedious convalescence, an almost equally prolonged typhoid condition, or death by exhaustion.

Black Vomit.—This has been found, upon chemical and microscopical examination, to consist essentially of blood, altered by action of the fluids of the stomach. It is usually acid to test-paper.

The *urine*, in yellow fever, is scanty and high colored at the beginning, and especially deficient in amount from the third to the fifth day. About the fourth day it becomes cloudy and deposits a sediment.

Morbid Anatomy.—Congestion of the brain is not uncommon; inflammation of the stomach is usual. The liver is most frequently dry, pale yellow, and anæmic; but occasionally it is engorged. Fatty accumulation in the liver has been repeatedly observed; and exudation into it is asserted. The spleen is little altered; the kidneys are always congested.

Diagnosis.—The only doubt likely to be entertained is as to its identity (or that of an example of it) with bilious remittent fever. As already remarked, the latter is a disease of the country, in any warm quarter of the globe. Yellow fever is restricted geographically, and is but seldom met with except in towns and near the sea. The order of stages in the two diseases is different; remittent never has a pyrexia lasting over twenty-four hours without mitigation. There is more epigastric tenderness in yellow fever. The jaundiced hue of the skin is more commonly met with, and is more positive, in that disease. The black vomit, when it occurs, is decisive. Possibly, even probably, in a few localities, the combined causation of the two fevers may produce hybridity between them. Immunity for a lifetime after one attack is common with yellow fever; not at all so with remittent.

Prognosis.—This is a very dangerous disease; the deaths from it averaging about one for three cases. A long and moderate febrile paroxysm, without excessive irritation of the stomach, is favorable. So is the occurrence of secondary fever instead of collapse, after the remission. Black vomit is almost always a fatal sign. Some instances of the disease are called *walking* cases, because their early symptoms are slight, only the countenance and pulse betraying the danger until near the end.

PATHOLOGY AND CAUSATION.—There seems no room to doubt that yellow fever is a zymotic disease, whose cause is generated by certain local conditions.

The conditions observed are, 1. Continued high heat; about 80° for one or two months. 2. Excessive moisture in the air; a high dew point. 3. Vicinity to the sea, or to a large river emptying into the sea. 4. Organic, especially vegetable, matter in a state of decomposition. This is furnished not only by the offal, etc., of cities, but by decaying wharves and causeways (as at Norfolk, Va.), and by newly upturned earth.

The *contagiousness* of yellow fever, from person to person, is still asserted by some authorities, although opposed by a great number of facts. A very few apparent examples of transmission by individuals, if admitted to have occurred, are otherwise explained. *Transportation by ships* is admitted by all, because a ship may carry a section, as it were, of a locality, with all its conditions and atmosphere. But, then, the port to which the ship goes must have all the conditions rife for the propagation of the disease, or its "germs" will not be maintained so as to cause an epidemic. When the disease has become endemic in a locality, the removal of as many of the population as possible ought to be advised.

TREATMENT.—No specific has been found for yellow fever, and no abortive treatment. All kinds of remedies have been tried for this in vain; especially bleeding, calomel, and quinine. In vain as to cutting it short; but in palliating and conducting it through its stages with safety, those and other remedies may be of use. Bleeding is suggested by the relief often attending spontaneous hemorrhages in its course; but, as in other malignant affections, the cases for it must be well selected, the time early, and the amount moderate. Much the greatest number will gain only by the application of leeches or cups to the epigastrium or back of the neck.

Many authorities approve of the use of calomel as a cholagogue cathartic, at least in a single dose (say of three or five grains), followed by a saline laxative, as citrate of magnesium, near the beginning of the attack. All the result of the use of *quinine* is, that it is not likely to do good at any early stage, but only when prostration begins to appear; and then in tonic or supporting, not *cinchonizing* doses. It is undoubtedly of service during convalescence.

Attention to the *stomach* is demanded by urgent symptoms. Ice, by the mouth, is refreshing and useful. So is mineral water, or iced champagne, a little and often; lime-water, charcoal water, and hot coffee have sometimes done service in arresting vomiting. A mustard or spice plaster over the epigastrium, or a blister dressed with acetate of morphia, may have an important effect upon the same symptoms.

During the hot stage, cold sponging to the face, body, and limbs, will sometimes promote perspiration better than any other measure. Enemata of cold water (with care not to chill too powerfully) have been used for the same end.

In the collapse, stimulation will be needed, by wine, brandy, or whiskey, etc.; along with concentrated liquid food, in small amounts at short intervals.

The experiments with anti-septic and anti-zymotic substances, as chlorine and the sulphites, made with other affections analogous to yellow fever, might be properly tried with it also.

Cerebro-Spinal Fever.

SYNONYMS.—*Cerebro-spinal Meningitis; Spotted Fever; Petechial Fever.*—The name adopted above is preferred in the absence of sufficient preponderance of authority or reason in favor of either of the other names. The disease is a systemic disorder; not a mere local phlegmasia.

HISTORY.—Often obscurely described, this disease appears to have been known in France in 1310 and 1482; over Europe, or parts of it, at various times since then.

In the United States, its first recorded visitation was in 1806, in Massachusetts. Then it gradually spread through the New England States, New York, and Canada, from 1807 to 1812, when it had reached Philadelphia. After that it was met with at various places until 1820; but with not great frequency. Between 1848 and 1850 it was epidemic in several of the Middle, Western, and Southern States, also in 1852 and 1858. Next we hear of it in 1862–3; as it occurred in the neighborhood of Philadelphia. Since that time (at which cases were seen especially at Frankford, Falls of Schuylkill, Manayunk, and Norristown, but only a few in the city) it has been observed in a number of places in Pennsylvania, New York, Ohio, and other States.

SYMPTOMS AND COURSE.—The attack is nearly always sudden. Chilliness, terrible pain in the head, extending to the back of the neck, nausea and vomiting, are the earliest symptoms. Delirium follows; ending not unfrequently in coma. Tetanic spasm or rigidity of the muscles of the back of the neck (and sometimes of the back and limbs), is common. Convulsions are much less so, but do occur, particularly in the young. Painful sensitiveness (hyperæsthesia) of the whole surface of the body is present in most cases, where there is no coma. Loss of sight and hearing may take place during the middle period of the attack. The pulse is at first slow, then accelerated, but diminished in volume and strength. Respiration is slower than natural in most, but not in all cases. The tongue is usually at first white and moist; sometimes natural; in prolonged cases it may become yellow or brown. The bowels are costive or natural.

The skin has almost always at the beginning an abnormally low temperature. When reaction occurs it does not become very hot as a rule. Dryness of the surface is most common, although late in the attack profuse perspiration may occur.

In a minority of the cases, though varying in proportion in different epidemics, *spots* (petechiæ) appear, on the second or third day, or later; on the neck, breast or limbs; seldom on the face. They are of different dimensions, from the size of a pin's head to three-quarters of an inch in diameter, and distinct; but not elevated nor disappearing on pressure. Their color is red, purple, or black. Sometimes they remain after death. They are either congested portions of the skin, or subcutaneous extravasations of blood.

The *duration* of fatal cases of this disease is generally short. Some die in three or four hours; many within twelve or twenty-four hours. That much time overpassed, the danger becomes less, but a fatal result may still occur, even after a number of days. The first four days are the most perilous to life.

Morbid Anatomy.—The blood, during life, is found to have an excessive proportionate amount of fibrin and corpuscles. After death, when this has taken place on the first or second day, no anatomical changes, even in the brain, have, in several instances, been found. Most generally, however, the brain and spinal cord show some alteration. It is the *pia mater* especially in which congestion, at least, is nearly always present. At the base of the brain, most of all, is this, often with serous and plastic exudation, observed. The surface of the hemispheres may also be diseased; and, next in frequency, the pia mater of the cervical portion of the cord. The ventricles of the brain have usually an excess of fluid in them; serum, either clear or mingled with blood or pus. The substance of the brain is more or less injected or congested; the spinal cord occasionally so. Softening of the brain is reported in protracted cases.

No other lesion or appearance is shown to be usual in this disease. A few observers record the presence of rather firm fibrinous clots in the heart.

Diagnosis.—From typhus fever, this is known by the suddenness of its onset, the early period of danger, and, in favorable cases, the rapid recovery; as well as by the peculiarity of the eruption. From ordinary inflammation of the brain, while the diagnosis may be very difficult, it differs in the unexplained abrupt attack, severe from the start; in the lowness of temperature during the first day or two; in the early tetanic tendency; and the eruption in many cases. Malignant scarlet fever resembles it considerably at the onset; and so does the chill of pernicious intermittent. Locality and season will designate the latter; age and exposure, especially, the former. Fortunately, the principle of treatment is not essentially different in these affections at the stage which may present a doubt.

Prognosis.—More than half the cases die. Those who survive three days, have a fair, though not certain, prospect of recovery.

Treatment.—We must lament the unsatisfactory condition of the evidence upon this subject. Almost all agree that *asthenia* characterizes the disease, most of all at the beginning. The resemblance to pernicious fever has suggested the use of quinine. And several very positive statements are made, of success with it in large doses; as, two to four grains every hour or half-hour until cinchonism is produced, or until from thirty to sixty grains have been taken; afterwards, a grain or two every two or three hours. Some practitioners, upon trial, have abjured quinine altogether in this disease. Bromide of potassium is preferred by many.

Opium has equally enthusiastic advocates and opposers. *Early*, if it be given, must be the time. The idea of those who urge it is, to give of it a grain every two or three hours, until an *opium sleep* is produced; then withdraw it or give it in much less doses.

Stimulation with brandy or whiskey is generally employed in the

first stage, with freedom. External stimulation is also, of course, indicated; by mustard, direct heat, friction with red pepper and brandy, or hot whiskey and salt, etc. Dry cupping, or in some cases cut cups (when reaction occurs) to the back of the neck will be proper; followed by a blister at the same place.

Cantharides (20 to 40 drops of the tincture, every hour till reaction), camphor, chloroform, and sulphite of sodium have each had laudation from some who have used them. But more favorable experience is needed to give the profession much confidence in the treatment of this affection.

Relapsing Fever.

SYNONYM.—*Famine Fever.*

SYMPTOMS AND COURSE.—Beginning rather abruptly, with chilliness, headache, and vomiting, with a white moist tongue, tenderness of the epigastrium, and constipation, the fever rises soon to a considerable height, with a full and frequent pulse, and a temperature on the second day of 104° or 105° F. Severe pains in the back and limbs occur; sometimes delirium. This exacerbation continues without distinct remission for from five to seven or eight days. Then a copious perspiration occurs, the temperature falls rapidly to 98°, or sometimes even less; and all the symptoms subside. The patient seems to be well. In about a week, however, (on or near the fourteenth day of the attack) a *relapse* takes place, which is characteristic of the disease. Its symptoms are much the same as those of the first paroxysm; its duration, from three to eight days.

PROGNOSIS.—In Great Britain, the deaths have numbered about 1 in 40 cases; in Russia, 10 or 11 per cent. In the Philadelphia Hospital, in 1871, of 517 cases, 80 died; the mortality being much the largest among colored patients.

PATHOLOGY AND CAUSATION.—This appears to be a specific disease. Its prevalence among the destitute of large cities in Europe has caused it to receive, at times, the name of "famine fever." Autopsic examination has shown a remarkable enlargement of the spleen in many cases; and alterations of the blood-corpuscles have been observed during life. It is believed to be contagious by many physicians, but did not clearly manifest that property in the Philadelphia Hospital.

TREATMENT.—A mild saline cathartic is proper at the beginning of the attack; followed by cooling diaphoretics, as solution of citrate of potassium or acetate of ammonium. When headache is severe, cups may be applied to the back of the neck. After the crisis of defervescence has occurred, quinine may be given in moderate doses, until the relapse. During the third week, a considerable number of patients will require support, with beef-tea and milk; sometimes, also, alcoholic stimulants.

Typhus Fever.

SYNONYMS.—*Ship Fever; Camp Fever; Jail Fever.*

SYMPTOMS AND COURSE.—For a day or two, premonitory weakness, headache, and loss of appetite occur. Then a cold stage, of

variable distinctness, begins the attack. In rare instances, it is said that death takes place in this, without reaction. Much more commonly, fever follows; with severe headache, great heat of skin, pulse 120 (110 to 130), but compressible, tongue whitish or yellowish, bowels costive. Delirium is common, especially at night. The temperature in the axilla is from 102° to 108°; generally, after the third day, 105°–6° in the morning, 106°–7° in the evening. Muscular debility is very decided.

For a number of days this condition lasts; the patient lying in a stupid half-sleep much of the time, muttering to himself, easily roused, but soon lapsing again; the face having a dusky flush of redness. Hardness of hearing is present in most cases. Positive coma is a very bad prognostic, but is not infrequent. Suppression of urine may take place in the worst cases; retention occurs in many severe ones. The tongue grows darker as the attack progresses; brown, even black; often cracked or fissured; and it as well as the teeth may be covered with sordes.

Towards the end of the first week, in most cases, a rash appears, of little and numerous red papulæ (miliary eruption), all over the chest, abdomen, and upper parts of the limbs. These are accompanied by *sudamina* (minute vesicles) in many instances, by *petechiæ* in a few. Sometimes a strong odor comes from the body.

The urine is scanty. Generally it contains an excess of urea and uric acid, with a deficiency of the chlorides. Sometimes there is actually less than the normal amount of urea eliminated; when excreta may be supposed to accumulate in the blood, promoting coma. *Costiveness* is the general rule in typhus.

The *dicrotous* or double pulse, and *subsultus* or twitching of the tendons at the wrist, are common. Weakness of the impulse of the heart is often noticeable; sometimes so much so as to justify Dr. Stokes' diagnosis of "typhous softening." *Hypostatic* pneumonia (*i. e.*, beginning with passive congestion of the lungs posteriorly) is the most frequent complication of the fever.

The *duration* of an attack of typhus is generally three weeks. Some writers speak of its typical duration as fourteen days. The critical period is about the eleventh day; after which *defervescence* (the decline of the fever) may be looked for. Occasionally death may take place within five days, or recovery within fifteen, from the commencement.

Morbid Anatomy.—Absence of lesion of the solids has been repeatedly noticed. The blood is always altered during life; after the early stage, it is less coagulable and darker in color than in health. Passive congestion in various organs is observed, as in the lungs, brain, liver, etc., but without anything characteristic.

Pathology and Causation.—No disease affords more reason for pronouncing it a disease of the blood than typhus. Its cause, demonstrably in many cases, is *ochlesis* or crowd poison; the effluvia from human bodies, accumulated, especially in cold weather, in small and ill-built dwellings of the poor, and most of all in filthy towns, ships, jails, or camps. Having once been thus generated, it becomes contagious: one patient having in his morbid emanations the poisoning power of a whole crowd. Yet the

contagion is not very strong; many who are exposed escaping the disease.

Diagnosis.—After the first two or three days (during which there may well be a doubt as to its character) the only probable question will be between typhus and typhoid fever. All medical authorities are not yet agreed as to the non-identity of the two forms of slow continued fever. A large majority, however, regard them as quite distinguishable during life, and separated pathologically by the absence in typhus of the morbid alterations of Peyer's glands, and those of the mesentery, characteristic of typhoid fever. Under the head of *Typhoid Fever*, the clinical differences will be enumerated.

Prognosis.—Murchison states the mortality in the hospitals of Great Britain, from typhus, to be one death in five cases. Cheyne and others in private practice have found it but one in twenty or more. Probably one in ten or fifteen would be a fair general estimate. Bad signs are, great feebleness or extreme rapidity of the pulse; profound coma; hiccough; suppression of the urine; involuntary defecation. Pneumonia complicating the attack increases its danger.

Treatment.—More than half the cases of typhus require alcoholic stimulation, as well as concentrated nourishment after the fourth day. But not all cases.

We may begin the treatment of an ordinary case of typhus with a mild laxative—*e. g.*, a *moderate* dose of solution of citrate of magnesium, on the second day. The diet at first may be of gruel, toast-water, etc.; but very soon must milk and beef-tea or chicken or mutton broth (or an alternation of these) be given to support the strength. Before the first week is out, half the cases will need wine in moderation; some, brandy or whiskey. In the second and third week, more than half the cases will require steady support of a positive kind. In such instances, the proper routine is, a tablespoonful of brandy or whiskey punch (one part of spirit to three, two, or one of milk) every two hours, and, the alternate hours, a tablespoonful or two of beef-essence or beef-tea.

Of medicines, quinine has had the most extended trial in typhus. It acts well as a tonic, in one or two grain doses, four or five times daily, after defervescence has begun: *i. e.*, after the tenth or twelfth day usually. Dr. Dundas' plan of treating typhus early with *large* doses of quinine is futile and even dangerous.

Mineral acids have acquired much reputation in typhus. Nitro-muriatic has been known to produce an excellent effect in the depression of the middle stage. Large doses are not required; but the acid should be given several times in the day. Some prefer dilute nitric acid. *Chlorine water* is lauded highly by some. The sulphite of sodium may be worthy of trial.

But the great point of skill will be to determine when and how far to stimulate. Delirium favors the probability of its being needed; especially a low, muttering delirium. Of course a very feeble pulse indicates it. On trial, if the pulse grows slower, the skin more moist, and the restlessness or delirium is quieted, the stimulus has done good, and should be continued. If, on the contrary, a more hurried or a *harder* pulse follow, with heat of head

and dryness of skin, and wilder delirium or deeper stupor, it should be stopped, for awhile at least, or, if given, be diminished in amount.

Catheterism may be needed for retention of urine. Inquiry and inspection should determine every day the state of the bladder. Constipation, through the attack, may be overcome by enemata, or by small doses of oil, Rochelle salt, or other mild laxatives.

When the coma is very deep, a blister to the back of the neck may do good; as well as sinapisms to the extremities. Great heat of the head may render proper, especially in the first week, the application of cold water to the head. Sponging the whole body daily (best at night) with whiskey and water, warmed, is extremely comforting and beneficial.

Hypostatic pneumonia, in typhus, cannot be treated actively. Even extraction of blood by cups is hardly ever to be ventured upon. *Dry* cups, between the shoulders, and a blister upon the breast, are about all the special treatment allowable. It is, however, possible generally to *prevent* hypostatic pneumonia, by not permitting the patient ever to lie for many hours together upon his back. Let him be turned, once in a while, upon one or the other side.

PROPHYLAXIS.—Thorough *ventilation* is the one security against the generation of typhus fever; and this is capable also of almost disarming its contagion.

Typhoid Fever.

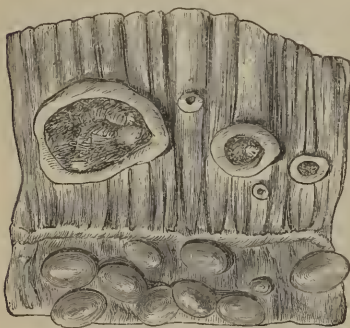
SYNONYMS.—*Slow Nervous Fever; Common Continued Fever; Enteric Fever; Abdominal Typhus* (Pythogenic fever of Murchison).

SYMPTOMS AND COURSE.—After a more gradual approach than that of any other fever, with languor and debility, anorexia and headache, for several days—bleeding at the nose, and a bronchial cough are almost pathognomonic early symptoms. The patient takes to bed, with fever of considerable violence. The face acquires a dark purple flush. He lies dozing, perhaps muttering, unless disturbed, all day; but is more or less wakeful and delirious at night. Hardness of hearing is common from the middle of the second week. Swelling of the belly (tympanites) comes on towards the end of the first week; diarrhœa about the same time. Rose-colored lenticular spots (*taches rouges*), disappearing on pressure, are discoverable, few in number, and on the abdomen only, toward the end of the second week; they continue a week or two. Tenderness on pressure in the right iliac region, with gurgling under the hand, generally exists. Sudamina over the chest are not unusual. The duration of the typhoid pyrexia is seldom, from the start, much less than two weeks, and it is often more; the whole attack of typhoid fever may be protracted, as I have seen it, to two or three months. One month may be considered the average time, from going to bed to leaving it convalescent.

Late symptoms in severe cases are, the dicrotous pulse, subsultus tendinum, retention (or suppression) of urine, hemorrhage from the bowels; and, if death be imminent, hiccough, cold sweats, involuntary discharges.

In protracted cases, great emaciation and bed-sores may supervene. Even during convalescence, abscesses in various parts of the body may give trouble. These usually affect the glands or connective tissue, but may occasionally involve the long bones.

Fig. 282.



ULCERATION OF GLANDS OF PEYER.

Danger of perforation of the intestine, from deep ulceration of the glands of Peyer, exists always after the first week, until late in convalescence. Patients out of bed for a week or two have sometimes died, after imprudence, from this cause. The occurrence of perforation is recognized by symptoms of severe peritonitis, with collapse. The result of this is almost inevitably fatal; the only recorded exception being reported by Prof. G. B. Wood.

Temperature.—This has, of late, been made a special study in typhoid fever. The rise from 98.5° (the normal degree) is gradual, during the first four or five days; reaching 104° on the evening of the latter; sometimes 104.5°. An attack of disease in which on the second day the heat in the axilla is as high as 104°, is not typhoid fever; and the same exclusion applies if from the fourth to the eleventh day the temperature falls below 103°. A difference of 1° or 1.5° between morning and evening (greatest heat, the latter) is usual; the reverse is not a good sign. Toward the end of the second week, lowering of the heat below 103° is always favorable; persistence at 104°, 105°, or 106° shows a severe case; the higher the worse. Sudden increase of temperature indicates a complicating inflammation; as pneumonia.

Discharges.—Liquidity of the stools is a characteristic of this disease, even if there be but one daily. Generally, after the middle of the first week, there are two or three passages, brownish with a slight yellowish tinge, every day. From the very beginning of the attack, the bowels are unusually susceptible to the action of purgatives; a teaspoonful of castor oil operating readily. Excessive diarrhœa, at a middle or late stage, not unfrequently adds to the prostration of the patient. Hemorrhage from the bowels, when it occurs, is most apt to be met with in the second or third week.

The *urine*, through the attack, is commonly scanty, high-colored, excessive in the amount of urea, deficient in the chlorides, and sometimes albuminous in severe cases.

COMPLICATIONS.—*Pneumonia*, especially the hypostatic form (as in typhus) is the most frequent. It has been, by some writers, denied that true pneumonitis, anything more than passive congestion, occurs in these cases. But, in the analogous instance of typho-malarial fever, especially when the scorbutic diathesis was

also present, I have seen, after death, more than once, suppuration, as well as hepatization, confined altogether to the posterior portions of both lungs. I do not doubt the same happening in typhoid as well as in typhus fever.

Inflammation of the brain may complicate typhoid, more often than typhus; but still it is not common.

Peritonitis follows always when perforation of the ileum takes place. Examples of its occurrence without that accident are said to have been, though very rarely, observed.

SEQUELÆ.—Prolonged debility, or a very slow convalescence, is common. The mental faculties are sometimes enfeebled for weeks or months. Paralysis is an occasional sequela. Abscesses have been mentioned. Periostitis, followed by necrosis, of the tibia, femur, or humerus, may happen. Perforation of the bowel may, as already stated, occur after convalescence has seemed to be established.

MORBID ANATOMY.—Omitting variable and unessential or occasional appearances, the parts characteristically affected in typhoid fever are, the agminated glands or patches of Peyer in the small intestine, the mesenteric glands, and the spleen. Careful study of Peyer's glands, by many observers, has shown that, at first, the glands thicken and become elevated from one to three lines above the membrane around them. They are generally at this time reddened; but with variable depth of hue. Sometimes, after this, a sort of induration occurs; in other instances, softening. Later, ulceration affects many, though not all, of the altered glands; and this process may go on until, as above said, it may perforate all the coats of the intestine. This, however, is exceptional. The healing of the ulcers by granulation is the general rule.

Fig. 283.

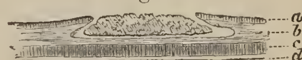


DIAGRAM OF A TYPHOID ULCER OF THE INTESTINE.—*a.* Epithelial lining. *b.* Submucous tissue. *c.* Muscular coat. *d.* Peritoneum.

The *solitary closed glands* of the small intestine are also commonly enlarged, and often softened or ulcerated. The *mesenteric* glands are almost uniformly enlarged, congested, and softened; occasionally they suppurate.

The *muscles*, especially the *recti abdominis*, in protracted cases, have been shown to undergo a granular, or sometimes a waxy or amyloid degeneration; resulting, in the rectus, occasionally, in rupture of its fibres.

PATHOLOGY.—Typhoid fever is believed by most authorities to be a general or systemic disorder, with a characteristic secondary local lesion in the intestines. How far the matter deposited in the patches of Peyer before ulceration is *specific*, is a question.

Dr. G. B. Wood holds the opinion that an inherent predisposition to the disease exists in many persons, analogous to the tuberculous, gouty, and rheumatic diatheses. This seems very probable.

Another view is, that the affection of the intestine is primary; and that the "typhoid" symptoms result from the absorption into

the blood of morbid, putrescent material from the glands of Peyer, producing a *septæmia* or *ichoræmia*.

CAUSATION.—More doubt exists as to this in typhoid fever than in any other common disorder. Depressing causes of all kinds seem to promote it; foul air, removal from home, fatigue, anxiety, etc. Yet it will occur in the entire absence of all such causes. No locality limits it; all climates allow it; from the Arctic regions to those bordering upon the tropical; from the cities of the East to the Rocky Mountains. The "mountain fever" of hunters in the far West was found in the autopsies of Dr. Hammond to present the lesions of Peyer's and the mesenteric glands.

Such universality is very much in the way of the "pythogenic" theory of Murchison (*i. e.*, its reference always to foul air, as that of sewers), or that of Budd, that its only cause is a specific matter, passed from the bowels of those having it, and, by water or air, conveyed into the systems of others.

Contagion of this kind is, nevertheless, widely believed in now, especially in England. Some facts asserted in proof of it are hard to explain without admitting such a mode of propagation (*e. g.*, by the discharges of a patient getting into a well, etc., so as to contaminate drinking water, or, sometimes, even milk). But many cases allow of no such explanation; most of all those occurring in the open country.

Typhoid fever is rarest in old age; not frequent in childhood; most common between fifteen and thirty years. Few have it under ten or over forty; almost none beyond fifty. It scarcely ever (relapses apart) occurs a second time in the same person.

DIAGNOSIS.—From *remittent* fever, typhoid is known by the absence of vomiting and sallowness of the skin, the slower onset, more protracted course, the *hebetude* or mental dulness and drowsiness, and the abdominal symptoms.

From *typhus* fever, the distinctive points are as follows:—

IN TYPHUS:	IN TYPHOID:
No epistaxis or bronchitis;	Epistaxis and bronchitis;
Bowels constipated;	Diarrhœa;
Belly seldom tympanitic;	Tympanites, gurgling, etc.;
Miliary eruption 5th to 7th day;	Lenticular rose spots;
Progress moderately slow;	Progress very slow;
Death often within ten days;	Death rarely within fourteen days;
Countenance dusky red;	Countenance purplish red;
Causation mostly obvious;	Origin obscure;
Anatomy not peculiar;	Lesions characteristic.

Cases called "febricula," or "irritative fever," (formerly "synochus") are described by some writers, and met with once in a while in practice, which give a good deal of trouble in diagnosis. Some of these, probably most of them, are mild examples of typhoid fever.

PROGNOSIS.—The mortality from this disease varies greatly under different circumstances. The possibility of perforation of the ulcerated bowel gives an element of uncertainty to every case. Probably one death in twenty cases will represent its average

mortality. The favorable and unfavorable symptoms, other than those common to typhus or other febrile affections, have been indicated sufficiently already, in our account of the disease. The state of the tongue especially at the period of defervescence (end of second week, about) should always be noticed, as it aids our observation of the abdominal symptoms in concluding upon the progress of the intestinal lesion.

TREATMENT.—Self-limited as typhoid fever is, no *cutting short* of it is possible. We must conduct the patient through it as safely as possible. For this, little medication, perhaps none, will suffice, with good nursing, in many cases. Yet this is not always proper or safe.

The simply palliative course of treatment has been followed with successful results. It is, upon the average, as follows:—

In the course of the first few days, if the bowels are costive, a teaspoonful of castor oil is given; after that, no laxative. During the first week, while the fever is highest, the tongue furred and often dry, skin hot and without perspiration, small doses of blue mass with ipecacuanha are prescribed, with a view of favoring freedom of the secretions. Afterwards, or at the same time, spiritus mindereri (liquor ammonii acetatis) is given, a tablespoonful (diluted) every two or three hours, from noon till midnight, as a diaphoretic.

Liquid food is necessary from the first. Oatmeal gruel, toast-water, rice-water, the first three or four days; then milk may be added, one or two tablespoonfuls every two or three hours. *Less than half* the cases of typhoid fever require alcoholic stimulation at any stage; not more than one-fourth of the cases need it before the middle of the second week, when the fever begins to decline. After that time, many require it, first, wine whey, half a wine-glassful about every three hours; later, when weaker, brandy or whiskey punch;—a tablespoonful of whiskey, for instance, every four, three, or two hours, sometimes every hour, with the same or twice as much of milk. Beef-tea is indispensable in nearly all cases, from the second week. It may alternate with punch, hour by hour. As in typhus, a patient prostrated with severe typhoid fever should be waked from sleep to take the required nourishment, night and day; otherwise he will sink for want of it.

Quinine has no place as a *curative* of this fever. It is useful as a tonic, after the critical period of passing the height of the fever; not more than eight or ten grains (in one or two grain doses) in twenty-four hours.

In the first ten days, headache and heat of the head may call for the application of cold to it; sometimes for leeches to the temples or back of the neck. Dryness and heat of the surface of the body may be best allayed by sponging all over (one part only uncovered at a time) with tepid whiskey and water. This operation, done in the evening, will promote sleep. Recently, *cool or cold baths* have been used (sometimes with success) to reduce the excessive temperature (hyperpyrexia) of this and other forms of fever; the patient, when the heat in the axilla reaches 104° or 106° F., being immersed for ten minutes once or twice daily in water at

70° F. Such a practice requires judgment in its use, and can hardly be regarded as free from danger.

Great tenderness of the abdomen may be treated by application of large poultices of hot mush, with which one-fourth part of mustard has been stirred. Diarrhœa being a symptom of the disease, it needs not to be checked unless the passages number more than three or four a day, or are uncommonly copious. Then, a pill of tannic acid and opium (3 grs. of the former to gr. $\frac{1}{4}$ of the latter), *pro re nata*—or *small* doses of paregoric or laudanum, will generally reduce it. Rarely is it necessary to use laudanum and starch enemata, or to add acetate of lead to opium in pill. Hemorrhage from the bowels is not apt to continue long, or to be dangerous. If it should, astringents, as lead and opium, by enema or by the mouth, must be used.

Shall we attempt to *medicate* the affection of the glands of Peyer? This also being symptomatic, its palliation only appears to be indicated. No special treatment for it is demanded in mild ordinary cases. But if, after the tenth or twelfth day, the *defervescence* does not take place, and restlessness is great, with abdominal tenderness, a dry tongue, and considerable diarrhœa, oil of turpentine is recommended by authority and experience. The dose should be not more than ten drops four times daily, in mucilage, with a few drops of laudanum, and a teaspoonful of glycerin to conceal the taste. Nitrate of silver is used instead by some.

Attention to the state of the bladder, day by day, to prevent or relieve retention of the urine, is important. Long protracted cases may demand a great deal of care to avoid severe bed-sores. In anticipation of these when threatened, frequent changes of position should be made, and the parts should be bathed with whiskey, spirits of camphor mixed with olive oil or lard oil, or soap liniment. The bed-clothes must be kept smooth under the person. Adjustment of pillows, with the addition of small ones made for the purpose, may do much. When a part is unavoidably pressed upon, it may be protected by a piece of kid spread smoothly with soap plaster. Actual excoriations must be treated like ulcers—with simple cerate, lime-water, poultices, adhesive plaster, etc., according to their condition.

Cholera.

Synonyms.—*Epidemic, Spasmodic, Malignant, Asiatic, Indian Cholera; Cholera Algida; Cholera Asphyxia.*

Symptoms and Course.—Premonitory diarrhœa, mostly painless and watery, occurs in most, but not in all cases. Its duration varies from an hour or two to two or three days. The worst epidemics of cholera, however, have been marked by some cases of fearful rapidity. In India, in a few instances, death has resulted by collapse in ten minutes.

Commonly, the diarrhœa increases in frequency and copiousness, and, in a few hours, vomiting commences. The discharges are colorless or "rice-water" like, and are spirted out with spasmodic force. The skin grows cold by degrees, and great debility comes on; with cramps in all the limbs, usually.

If not checked, *collapse* arrives; with intense thirst, oppression

in breathing, loss of voice, disappearance of the pulse, suppression of urine, cold, *blue*, and shrunken skin, sometimes bathed in sweat, and, at last, cold breath; ending in death. This occurs, on the average, in about eighteen hours.

When reaction takes place, recovery may immediately become complete; or, a low fever may supervene. The termination of this may be in death within a few days, or recovery in a week or two.

Appearances after Death.—Rigidity occurs *soon;* sometimes in less than an hour; generally within two hours. Startling *movements* of the corpse have been several times noticed; as of a patient, dead with cholera, slowly lifting both hands over the chest and joining them; opening the eyes and rolling them downwards, etc. *Increased heat* of the body, cold during the attack, has been sometimes observed after death. Internally, several of the great organs, the brain, spleen, and kidneys at least, are commonly gorged with blood. So are the *right* cavities of the heart; but the left side of the heart is empty or with but little blood, and firmly contracted. The lungs are almost bloodless. The liver varies in appearance; but the gall-bladder is almost always *full of bile*. The urinary bladder is, constantly, greatly contracted. The stomach and intestinal canal are congested and swollen; the late Prof. Horner observed the frequent throwing off of the "epithelial" lining of the canal; Böhm, of Germany, confirmed this; Drs. Parkes, Gull, and Lindsay assert it to be a *post-mortem* occurrence.[1] The intestinal glands are found considerably enlarged. The *blood* has been carefully examined by Drs. Garrod, Schmidt of Dorpat, and others.[2] Its water and salts transude into the alimentary canal, with some of the albumen and fibrin; also *the contents of the blood-cells transude into the serum.* The blood drawn from a vein during life is dark, thick, and tarry, scarcely capable of flowing. Schmidt found the amount of oxygen in the blood-corpuscles less than half the normal proportion. The blood is *acid* sometimes in cholera; the reverse of its natural reaction.

The *ganglia* of the "sympathetic" system have been often examined, and are frequently changed in appearance; congested, softened. altered in color; but no *special* change has been shown to belong to them in cholera.

Diagnosis.—Common cholera morbus alone, when severe, resembles epidemic cholera so much as to be easily mistaken for it. The *collapsed* stage of the one, preceding death, is almost identical in appearance with collapse of the other. But cholera morbus is *caused* by some irritant of the stomach and bowels, and is clearly an affection of *those organs*, not a *toxæmia* or systemic disorder; it is sporadic, *not epidemic;* in it the discharges are always *bilious* at first, and mostly so to the last; collapse in any degree is *rare*, and death, under judicious treatment, very uncommon. In all these things, it differs greatly from Asiatic cholera.

History.—Cholera must have existed in India for an indefinite time. From 1781–2 dates its extended prevalence, in a most de-

[1] Edinburgh Med. and Surg. Journal, Jan. 1855.
[2] Brit. and For. Medico-Chirurg. Rev., July, 1854.

structive form; at Calcutta, in Madras, on the Coromandel coast, and in Ceylon.

In August, 1817, Jessore was the birth-place of the first great migratory epidemic. Thence it spread gradually through Western Asia into Europe; reaching England in 1831. In 1832 it first visited America; afterwards, it prevailed to a greater or less extent in this country in 1833, 1849, 1850, 1854, 1865, and 1866. In these and other years, most parts of the world have in turn been invaded by this pestilence, which, except in India, seldom continues long at a time in one place.

CAUSATION.—As to this, all cannot yet be known. But it is clear that the cholera must have a specific, material, migratory cause. Dr. G. B. Wood, Dr. Austin Flint, Dr. Snow, of Providence, and some foreign authorities, for example, Dr. Southwood Smith, "the father of modern sanitary reform," have believed that cholera is *not personally contagious.* Yet its contagiousness, through the stools of patients, is maintained by such high authorities as Dr. W. Budd and others in England, and by Prof. A. Stillé, Dr. A. N. Bell, and others in this country.[1]

In Europe and the United States, as well as in India, influences belonging to closely aggregated communities have always been observed to display a power to propagate cholera. It comes most often, stays longest, and is most destructive, in the densest and filthiest cities, and in the worst quarters of those cities.

Very important testimony exists as to the influence of the *drinking water* of localities. Dr. Snow, of England, asserted the theory that this was the almost universal medium of its propagation. All such testimony is still available in regard to the propagating and extending power of *animal contamination.*

The theory at present most in vogue, in regard to the propagations and extensions of cholera, is based upon the observations and reasonings of Pettenkofer and Thiersch. According to this view, the specific cause of cholera either exists in the "rice-water" discharges, or is formed by a process of change in them after evacuation. This specific cause, then, is transmitted from a cholera patient to other persons, mainly by water-courses, above or under the ground; sometimes, possibly, in the form of dry dust, through the air. This theory points especially to the importance of *disinfection of cholera stools as soon as they are passed;* a measure of precaution amply sustained upon general grounds independently of the theory.

SANITARY POLICE includes the most available measures for the prevention of cholera in any place.

On this ground, the measures required are obvious, and familiar. The thorough and frequent cleansing of all streets, alleys, courts, wharves, and vessels, private and public buildings, and empty lots; the abatement of all nuisances; daily removal of offal; effi-

[1] The opinion of the author of this Manual is, that cholera traverses the globe with very little dependence upon human transportation; although the circumstances of populous localities undoubtedly promote its continuance and extension. See "Cholera: Facts and Conclusions, etc.," by H. Hartshorne, M.D., Philada., 1866.

cient sewerage; and *conservancy*, *i. e.*, the cleansing, ventilation, and disinfection of cesspools and water-closets. Among all signs of danger of the location of cholera, none is more significant than the *privy odor*. Let it be everywhere annihilated. Lime, charcoal, dry earth, chloride of lime, Labarraque's chloride of soda, carbolic acid, liquid coal tar, chloride of zinc, and sulphate of iron are the most available of disinfectants.

The fresh white-washing of cellars is useful; thorough ventilation and drying of them and of all parts of habitations, still more so. Chloride of lime may be placed in a saucer, in any suspected room or other locality in a house. The same in the solid form, or solution of green vitriol, may be thrown daily into a foul privy; and, during cholera time, especially in the case of patients with the disease, every water-closet and vessel used may and should be disinfected constantly, by a dilute solution of chloride of zinc, chloride of soda, permanganate of potassium, or carbolic acid. The immediate removal of all discharges from the sick-room, their disinfection, and transportation to the safest possible place of elimination, ought to be imperatively maintained. All foul clothing must be properly washed, or, if very bad, disinfected or burned.

TREATMENT.—To *discuss* all the modes of management proposed for cholera, would occupy too much space. We shall merely *enumerate* those which have attracted the most attention.

1. *Bleeding.*—This was largely practised in India, in 1818–1825, by Corbyn, Scott, Annesley, and others. As many positive facts have been asserted on behalf of the success of bloodletting as of any other remedy in cholera. It is now, however, entirely out of vogue.

2. *Calomel.*—This was an old East Indian remedy. Suggested by the almost universal absence of bile in the discharges, which was thought to indicate the need of stimulation of the torpid liver, it has been more largely given than any other medicine in cholera.

Many hold the opinion that calomel is of no use in cholera. The argument in its favor, from the absence of bile in the stools, is rebutted by the fact of its abundance in the gall-bladder; while the clinical experience quoted for its success is accounted for by the addition to it, almost always, of opium, in the prescription. Nor is the amount of success with it, even then, great. Such is Dr. Gull's conclusion, based upon the examination of a great mass of evidence, given in his report.[1]

Dr. Ayre, a British practitioner of some note, gave prominence to a modification of the old calomel treatment (in which twenty grains were sometimes given at once), by prescribing a grain of calomel every five minutes during the attack.

3. *Saline Treatment.*—Dr. Stevens, of Jamaica, proposed this, upon the view that the main pathological element in cholera was the loss of salts from the blood in the discharges. After the general failure of saline solutions (of common salt, carbonate and phosphate of sodium, etc.), given by the mouth, had been conceded,

[1] Report, etc., of Drs. Baly and Gull.

Dr. Macintosh, of Edinburgh, and others, tried the method of injection into the veins (half an ounce of common salt, and four scruples of sesquicarbonate of sodium, dissolved in ten pints of water, at 105° to 120° Fahrenheit). Under this plan, resorted to during collapse, of 156 patients, only 25 recovered. Remarkable improvement, almost like a resurrection, appeared in several, who afterwards fell again into collapse, and died. The suggestion has been recently made, that it may have been the *temperature* of the injected liquid which produced the benefit, so promising and yet transient.

4. *Eliminative Treatment.*—Dr. George Johnson, of London, has urged this with especial vigor. The castor-oil medication of cholera owes its trial to him. A prominent idea with him is, that the general collapse is due especially to anæmia of the lungs, owing to spasmodic contraction of the pulmonary artery and its branches. But the essential feature of Dr. Johnson's pathology is the opinion that, the disease being toxæmic, a morbid poison exists which must be *eliminated* from the blood; and that the discharges are the media of this elimination. Therefore, the vomiting and diarrhœa are salutary or relieving; and ought to be rather encouraged than checked. He goes even so far as to repudiate the commonly accepted belief, that "premonitory diarrhœa" or "cholerine" ought to be checked; considering it a fallacy to assert that those who are relieved of such symptoms by mild treatment were really, or would have been, affected with cholera at all.

These views have very few advocates or supporters, besides the distinguished physician whose name and ability command for them at present careful consideration, and the eminent Sir Thomas Watson, of London. It is true that patients have died of cholera without vomiting or purging; though, in some, after death, the intestines have been found to be distended with the rice-water liquid. But the checking of the discharges is almost always the sign of improvement and recovery of the patient. And we cannot, on Dr. Johnson's dictum, set aside or quash all the accumulated evidence, in Europe and this country,[1] which shows that it *is* desirable and important to *check all watery diarrhœas in cholera times*—such fluxes having been proved to be often premonitory of cholera attacks.

5. *Ice to the Spine.*—Dr. John Chapman's ice-bags have attracted much attention. As ice is so useful when internally given in cholera, it *may* be safe and beneficial when applied to the spine. It is one of the experiments to consider, in so desperate a disease. There is very little evidence, however, in its favor.

6. *Sulphuric Acid.*—Dr. Cox, of England, afterward Mr. Buxton and Dr. Fuller, and more recently Dr. Jules Worms, of Paris, have especially recommended dilute sulphuric acid in all stages of cholera. Many others especially report well of its action in the *premonitory diarrhœa.* Such an action would comport perfectly

[1] See Lectures on Cholera, by Prof. A. Clark, of New York; Report to the Royal College of Physicians, 1854; also, Madin, Briquet, and Mignot, etc.

with the view of the *organic* nature of the poison of cholera; sulphuric acid being so potent a destroyer of everything organic. Some confirmation of the efficiency of this practice was obtained by Dr. Curtin, in the Philadelphia Hospital, in 1866.

Dr. Worms' treatment (based on the results in 238 cases of cholera, and 150 of cholerine, in 1865) is as follows: For prodromic diarrhœa, he makes a "mineral lemonade," of about half a drachm of concentrated sulphuric acid to a pint or more of sweetened decoction of salep (arrowroot would do as well). The patient is to take of this every hour a wineglassful, till relieved.

For confirmed cholera, the patient being kept in complete repose, there is administered every half hour a glass of a similar lemonade, of the strength (about) of a drachm to the pint; ice and wine also being allowed *ad libitum.*

7. *Opium in large doses.*—This practice had once many advocates; now they are few. Prof. Austin Flint, of New York, is one of them; at least *morphia* is advised by him, in full dose, repeated if required. The *secondary fever* is apt to be more severe and more often fatal after treatment of the attack by large doses either of opiates or stimulants. Large quantities of brandy have been often used, with no good results.

8. *Treatment by antispasmodics and mild stimulants, in small doses at short intervals; with ice, and external frictions, etc.* Premonitory diarrhœa is very generally admitted to be present in a majority of cases of cholera.[1] In the East Indies, many writers of different dates assert such a stage to be an exception instead of the rule. But, in India, they have a premonitory or incipent stage of another kind; characterized by great languor or depression, with restlessness, and sometimes ringing in the ears, occurring mostly in the night. Stewart Clark states[2] that, in this stage, a mild opiate ("with a little calomel or blue pill"), with a cup of warm tea or a small dose of a diffusible stimulant, as a few grains of carbonate of ammonium, or a little weak warm brandy and water, will arrest the attack in a great portion of cases otherwise to become serious.

Such symptoms, as well as diarrhœa, should be noticed here, during a cholera epidemic; and the same treatment will meet either. Rest, warmth, and mild, composing, but gently stimulating draughts; paregoric, aromatic spirit of ammonia, tincture of ginger, lavender, etc., with a mustard-plaster over the abdomen, and a hot mustard foot-bath if coldness of the body increase, or vomiting begin; such are safe, and will be efficient remedies. The above may be called the first or prodromic stage.[3]

The next has been well called, by Prof. A. Clark, the *rice-water* stage. For that, the treatment of the late Prof. Horner is particularly adapted. A recipe, based upon his, is as follows:—

[1] Barraut asserts fixed contraction of the pupil to be the first prodromic sign; M. Worms makes the same statement in regard to albuminuria.

[2] Hygiene of the Army in India, p. 12.

[3] The recently published experience of Dr. Hamlin, in Constantinople, confirms the importance of the above early treatment.

℞. Chloroform. et
Tinct. Opii et
Sp. Camph. et
Sp. Ammon. Aromat. āā f℥jss;
Creasot. gtt. iij;
Ol. Cinnamom. gtt. viij;
Sp. Vin. Gall. f℥ij.—M.

Dissolve a teaspoonful of this in a wineglassful of ice-water; and give of that two teaspoonfuls *every five minutes;* followed each time by a lump of ice.[1] Iced water, or rice-water, to which common salt and carbonate of sodium have been added, may be given, a little at a time, as a drink. Also give a tablespoonful of brandy every hour or two.

Friction of the limbs with brandy and red pepper will be, along with large mustard-plasters on the back and pit of the stomach, useful to promote reaction.

The third stage is that of absolute collapse; blue, pulseless, shrunken, voiceless. Should a case go on, in spite of the above-mentioned treatment, into this state, what else can be done? All now seems to be desperate experimentation.[2] There is room yet for, and possibility of obtaining, a final triumph.

CHAPTER II.

DIATHESES.

Rheumatism.

SEVERAL affections are, in popular language (partly sanctioned by medical usage), included under this term. 1. *Acute articular rheumatism* or *rheumatic fever*. 2. "Chronic rheumatism," affecting the joints and sheaths of the muscles. 3. Syphilitic rheumatism, of the long and flat bones. 4. "Rheumatoid arthritis." 5. Myalgia. 6. "Gonorrhœal rheumatism."

Acute Rheumatism.—Only certain persons and families are liable to this affection, upon any exposure. It is characterized by high fever, with severe inflammation of several of the larger and smaller joints; which, mostly one after another, become swollen, red, hot, tender, and painful. The shoulders, wrists, knees, and ankles are most frequently so affected. Although with a full and rapid pulse, the skin, after the first week or so of the attack, is often bathed in perspiration. The duration of an attack under various

[1] We take from Dr. Aitken's Practice the following recipe, much used and approved in India and England:—℞.—Ol. Anisi, Ol. Cajuput., Ol. Juniperi, āā ℥ss; Æther, ℥ss; Liq. Acid. Halleri (*i. e.*, one part concentrated sulphuric acid to three parts of rectified spirit), ℥ss; Tinct. Cinnam., ℥ij.—M. Dose, 10 drops every ¼ of an hour, in a tablespoonful of water.

[2] Duchaussoy and Vernois assert the non-absorption of medicines given by the stomach during the collapse; but Magendie proved that a very slow absorption does occur.

modes of treatment has averaged two or three weeks. Sometimes it extends over months; and the *sequelæ*, or resulting *crippling* of the articulations, may remain for a lifetime.

The *danger* in rheumatic fever consists in the liability to endocarditis and pericarditis. A *complication* of it, occasionally met with at a late stage, is *chorea*. Rheumatism may undergo *metastasis* from the joints to the bronchial tubes (rheumatic bronchitis), or, much more rarely, to the membranes of the brain. In feeble persons the bowels or the womb may occasionally be involved.

The *blood* in acute rheumatism is found to contain an excess of fibrin. *Lactic acid* has, upon some basis of observation and experiment (Richardson), been asserted to be in excess in the blood as the characteristic pathological element in rheumatism.

Apart from the cardiac affections possible in its course, rheumatic fever is not often dangerous to life; but it is very painful and debilitating.

TREATMENT.—Many methods have been and still are in use. *Calomel and opium; opium* alone, or with ipecac, as in Dover's powder; *lemon-juice; quinine; colchicum; alkalies;* these are the most important. The conclusion of many upon the subject is, that the *alkaline* treatment is the best. Carbonate or bicarbonate of potassium with the Rochelle salt or nitrate of potassium (in scruple doses of the carbonate, or half drachm of the bicarbonate, with about the same of either of the other salts), thrice daily, will answer. Opiates, especially Dover's powder, at night, may do great good. Local applications of *laudanum* (detained by oiled silk) to the painful joints, give great relief.

Lemon-juice has seemed a useful adjuvant (tablespoonful doses every three hours) in cardiac inflammations of rheumatic origin.

Quinine is sometimes very beneficial in enfeebled cases with *free perspiration*. 10 or 15 grains may be given in a day.

Colchicum is of decided service only in the presence of the gouty diathesis.

Remarkable success has recently been reported in the treatment of rheumatism by "flying blisters;" *i. e.*, the successive application, to different affected parts, of small blisters; allowed to produce moderate vesication only. Several British physicians laud this practice.

Propylamin has been tried and generally found wanting in value.

Chronic Rheumatism.—Any one may have this affection, which is, however, most common in those advancing in age. It is a sort of slow inflammation of the fibrous tissues investing the joints and muscles, following exposure to cold and wet. The aching pains are apt to be worst at night.

Cold may produce pain, without any inflammation. Five minutes' exposure to a draught of damp air will often so affect different parts of the body; relief being at once obtained on the application of warmth.

The TREATMENT of chronic rheumatism has been largely experimental. The medicines most given are, iodide of potassium, guaiacum, oil of turpentine, and cod-liver oil. Alkalies and colchicum do not signally affect it. Opium is seldom required unless locally. Local treatment generally does more for it than medicine.

For this, various liniments are useful. None are better than those containing oil of turpentine, oil of sassafras, ammonia, and laudanum, diluted with soap liniment; or, where pain is considerable, chloroform or aconite liniment. Blisters may be applied in obstinate cases.

Dry cupping to the back, leaving a number of cups on for twenty or thirty minutes at a time, makes a more pervading favorable impression, sometimes, than might have been expected. For rigidity of the joints, and even for pain in them or in the muscles, *pouring hot water* continuously over the parts does great service. The *hot bath*, or *vapor bath*, or, as some prefer, the hot dry-*air* bath (130° to 200°) will be powerful for relief in many cases. Galvanism also will aid in hastening the restoration of use to the stiffened parts. Wrapping rheumatic joints in *cotton* is often very serviceable. Those subject to rheumatism should wear flannel the whole year.

Syphilitic Rheumatism.—As stated already, this affects the long and flat bones chiefly, and mostly *between* the joints, not at them. Generally there is *nodosity* upon the bones affected, or some degree of periosteal inflammation, at least.

The remedy for syphilitic rheumatism is iodide of potassium. It will usually relieve the pains in a few days. They may return in the course of months or weeks, when the same treatment should be renewed. (Ten to twenty grains of the iodide, thrice daily, will suffice.)

Rheumatoid Arthritis.—This designation is applied by authors to a form of subacute or chronic inflammation of one or more large joints, of greater severity than ordinary chronic rheumatism. Effusion into the joint, with deformity and permanent or at least long-continued lameness, may occur.

Can rheumatism and gout ever actually be combined in the same patient, in a hybrid attack? They can at least be so far blended together that inflammatory rheumatism, in a patient of gouty constitution, is more affected by the state of the digestive organs, and is more beneficially acted upon by colchicum, than in others.

Myalgia.—Dr. Inman, of Liverpool, first gave this name to *muscular pain* without inflammation or other defined disease. It is more often met with in the *back* and *chest* than elsewhere. Debility and fatigue are its principal causes; although muscular pain may follow from the direct impression of cold.

Rest, *warmth*, and tonics meet the general indications for the treatment of myalgia. Anodyne applications, as aconite liniment or tincture, or veratria ointment, will be required only in a few cases. The hot bath or douche will often give relief.

Gonorrhœal Rheumatism. — After Sir Astley Cooper, several English and French writers have described a peculiar inflammation of one or more joints, occasionally commencing in the course of gonorrhœa, or even of urethral inflammation from forced catheterism. The local affection may be severe, with suppuration in a few cases, and anchylosis of the joint in many. It appears to be an *ichorhæmic* affection; *i. e.*, the result of absorption into the blood of morbid matter effused into or formed in the membrane of the urethra.

TREATMENT.—Chambers and Brodhurst, on the ground of experience, recommend *active* treatment for this affection; by moderate bleeding, general in the robust, and local in others; followed by blisters, the hot-air bath, chloride of ammonium, and opiates at night.

Gout.

SYNONYMS.—*Podagra; Arthritis.*

Gout is a *diathesis*, or constitutional disorder, more or less persistent, with local affections, mostly inflammatory, occurring in paroxysmal attacks.

SYMPTOMS.—Premonition of a gouty spell is often witnessed for some days, with symptoms of indigestion; flatulence, acidity, constipation, palpitation of the heart. Then (or without such warning) a joint becomes very painful, swollen, red, and tender. In a majority of cases the *great toe* is affected. Other toes, the fingers, ankle, wrist, or knee may be attacked; the large joints least often. Towards the end of the spell, *tophaceous* or chalk-like deposits (chiefly of urate of sodium and calcium, altering with time in part to carbonates) are thrown out about the joint, in some but not in all cases.

The suffering with the gouty inflammation is often very intense; but its duration is not commonly of more than a few days at a time. Aptness to return, at intervals shortening with each attack, is an unpleasant feature. When the period of release is so short as to be almost absent, it is called *chronic* gout.

Retrocedent or *Misplaced* gout is that in which, instead of the small joints, some internal organ is affected; as the stomach or heart. Such attacks are violent and threatening to life; but generally brief. Exposing an inflamed gouty foot to cold may "drive in" the disease, or produce a metastasis.

If the *stomach* be so involved, nausea, vomiting, and spasm or cramp of the stomach are experienced, which, unless relieved in a short time, prostrate the patient very much. When the *heart* is the organ seized, its action is interfered with so as to cause distress in breathing, pallor, faintness, and debility.

The *urine*, during the attack of gout, is scanty, with its usual amount of urea, but a deficiency of uric acid, until near the close of the spell; when the latter is increased. The *perspiration* not unfrequently contains an excess of uric acid and the urates, particularly urate of sodium.

Hereditary gout is sometimes genuine *Podagra*, or foot-gout, but more often is of the *wandering* kind. Neuralgia, indigestion, palpitation, and urticaria or eczema upon the skin are its most common manifestations. In such a system, rheumatism and other affections are to a considerable degree modified by "the gouty tendency."

MORBID ANATOMY.—Except the deposits of urates about the joints, and the proved excess of uric acid in the blood, the only peculiar alteration belonging to the anatomy of gout is, the shrinking and granular degeneration (with some deposit of urate of sodium) of the kidney; the "gouty, contracted kidney" of Todd. The urate deposit is pathognomonic of gout.

PATHOLOGY.—Garrod has established the doctrine of the cha-

racteristic of gout being *excess of uric acid in the blood.* The *origin* of this excess is still doubtful. The view of Mialhe is plausible, that urea being more highly oxidized than uric acid, deficiency of oxygenation of the blood may increase the amount of uric acid in it, unchanged.[1] Also, imperfect action of the kidneys may, by their not depurating the blood fully, induce the same accumulation.

CAUSATION.—High living with indolent habits, generates gout. Even excess of animal food, with scanty exercise, has been known to produce it. But strong wines and malt liquors much increase the tendency. Weak wines do not seem to have the same effect. In the Rhine region gout is rare. Nor do spirits produce it readily; their effects, when abused, are different, though worse in the end. Hereditary transmission of the gouty constitution is very common.

DIAGNOSIS.—Between gout and rheumatism there is great resemblance; and, as I have observed, they may be blended together. When clearly exemplified, the following differences exist:—

In gout, the small joints are chiefly affected; in rheumatism, the larger joints. Repetition of attacks is much more frequent in gout; their duration is greater in rheumatism. In gout, the heart is seldom attacked, and *spasmodically;* in rheumatism, the heart is often subject to *inflammation.* In gout, the stomach is sometimes spasmodically affected, with violent symptoms; in rheumatism, almost never, although the bowels may be. In gout, and not in rheumatism, uric acid (or urate of sodium) is in excess in the blood. In pure gout, colchicum generally does good; in pure rheumatism, hardly ever.

TREATMENT.—During the attack, colchicum and the alkalies are the remedies. Wine of the root (some prefer that of the seeds) of colchicum may be given in ten to twenty drop doses several times daily. The stomach and bowels are sometimes irritated by large doses; but for a few days, most patients will bear fifteen drops thrice daily. It should be stopped when relief has been obtained. Carbonate of potassium, ten to thirty grains at once, with half drachm doses of Rochelle salt, will be important in addition. Opiates or other anodynes may be craved by the patient during the extremity of his pain.

Shall any local application be made? Not cold to reduce the inflammation. More than one death has occurred from this, by repulsion of the disorder to the heart, stomach, or brain. Laudanum may be safely applied to the part, as in rheumatism, by wetting a piece of linen or muslin with it, laying it on the painful joint, and covering it with oiled silk. Alkaline washes (not too cold) are sometimes used.

Gouty attacks affecting the stomach or heart spasmodically are usually sudden, violent, and prostrating; requiring prompt stimulation, as by brandy, laudanum, Hoffmann's anodyne, chloroform, or Warner's cordial (tinct. rhei et sennæ). Small or moderate doses of one or another of these should be given at *short intervals.* Mustard plasters to the epigastrium, or chest and back, will be

[1] *Headland* and others advocate a quite different view.

important; and the feet may be placed in hot mustard water for revulsion.

Breathing oxygen has been lately proposed as a remedy for the gouty state of the blood. Its utility has not yet been decided upon by sufficient trial.

The *prevention* of attacks, by the removal of the diathesis and predisposition, is often very difficult, even in the absence of hereditary taint. Regulation of the diet is of primary importance. But it should not be too low, especially when the patient's habits have been those of free living. Nourishment must be full, while the digestive power is economized, and positive stimulation avoided. Exercise, in proportion to strength, should be recommended. In some weak or old cases, tonics may be called for; vegetable bitters particularly. The state of the *skin* and that of the *bowels* are important.

Change of air, travelling, and mineral waters are generally useful during the intervals between the paroxysms. Alkaline springs and baths (such as that of Vichy in France, or Ems in Germany) have an especial reputation as prophylactics against gout.

Scurvy.

SYNONYM.—*Scorbutus*. This affection was once very destructive to voyagers at sea, and explorers of barren regions, as well as sometimes to large armies. Captain Cook has the credit of proving the preventive value of vegetable food. Dr. Lind, his contemporary, published a work on scurvy in 1757, advocating the antiscorbutic use of oranges and lemons. Still, in their Arctic expeditions, Drs. Kane and Hayes were much incommoded by this disease. In the Crimean war, and during the late war in this country, although uncomplicated scurvy was not very frequent, the *scorbutic diathesis* modified other diseases and increased mortality to a serious extent.

SYMPTOMS.—Languor, debility, and lowness of spirits first occur. Then swelling, sponginess, and bleeding of the gums are observed; the teeth loosen, and the breath is offensive. Palpitation of the heart and dyspnœa may be present. Petechial spots (from subcutaneous extravasation of blood) appear on the limbs; sometimes the legs swell from fibrinous deposits, especially at the ham. Diarrhœa and dysentery often come on. Death may take place by gradual exhaustion, or by sudden syncope.

DIAGNOSIS.—*Purpura hemorrhagica* is undoubtedly not identical with scurvy, although "purpuric" extravasations are common to both. Purpura does not depend, as scurvy does chiefly, upon a fault of diet; nor are the gums affected in purpura.

CAUSATION AND PATHOLOGY.—That the essential cause (*sine qua non*) of scurvy is deprivation of fresh food, and, in almost all cases, of fresh *vegetable* food, is proved. Fresh meat will retard it, in the absence of vegetables; but neither this nor oranges and lemons will altogether prevent it through long periods. Additional *promotive* causes are severe cold, fatigue, and exposure, and mental anxiety or home-sickness.

Further than this the pathology of scurvy has not been determined. The hypothesis that it depends upon *deficient alkalinity*

of the blood is disproved by the failure, in many hands, of potassa and its compounds to hasten the cure, or insure prevention.

TREATMENT.—Medicine here is almost valueless. Fresh vegetables alone will restore what is wanting, though chemistry has not detected the nature of the need. Potatoes, tomatoes, oranges, and lemonade are the most generally available articles. If any medicine is useful as an adjuvant, it is the tincture of the chloride of iron, in moderate doses. Sometimes citric acid does good.

For the gums, a wash of solution of tannic acid or tincture of myrrh in diluted glycerin will be useful; or alum, brandy, and water. Salt and whisky rubbing of the skin will aid in dissipating the petechiæ.

PROPHYLAXIS.—Medical men in charge of expeditions to a distance from ordinary supplies should always insist on measures being taken to furnish enough fresh vegetables, or, next best, *desiccated* potatoes. After the latter, onions, tomatoes, turnips, etc., and oranges and lemons rank. *Wine* is also decidedly though not infallibly scorbutic. The leaves of the pokeberry plant (*phytolacca*) and of the *cactus opuntia*, are so. Raw meat is better, in the arctic regions, for the same end, than that which is cooked. The experience of the army, during the late war, shows that neglect of the means of preventing this disease will sometimes cost far more than those means themselves, whatever difficulties they may seem to present.

Constitutional Syphilis.

Weeks or months after the primary disease, *secondary* syphilis may show itself. Once produced, although sometimes readily curable, it often impairs the constitution for life, and transmits the taint to offspring.

The affections belonging to secondary syphilis are—peculiar copper-colored eruptions, rupia especially; warts about the genitals; ulcers of the throat; iritis; loss of hair (alopecia); affections of the testicle or uterus. These last, as well as *periostitis* and osseous tumors or *nodes*, cutaneous tubercles, and chronic degenerative inflammations of the brain, spinal marrow, liver, spleen, lungs, etc., are often called *tertiary* syphilis.

General experience and opinion have asserted that constitutional syphilis is not transmissible by inoculation. Some recent experiments have placed this question again "sub judice."

TREATMENT.—Mercury is available in the treatment of secondary as well as primary syphilis; but its power over it is less absolute. After moderate trial of its impression (especially of the iodide of mercury), iodide of potassium may be given; from ten to thirty grains thrice daily. It is an almost certain cure for syphilitic "*rheumatism*" or bone pains, with or without nodes. Over ulcers of the throat, also, it has great power. Such things, however, often do not *stay* cured; they break out again, as may also the cutaneous eruptions; requiring the same treatment over and over.

Donovan's Solution[1] internally, and mercurial ointment locally, are the only additional remedies among many proposed and often

[1] Liquor Hydrargyri et Arsenici Iodidi. *Dose*, 3 to 5 drops.

used, that it is worth while to name in our brief consideration of the subject. Of course, enfeeblement of the constitution of the patient may require the employment of generous diet, salt bathing, change of air, iron, quinine, or cod-liver oil.

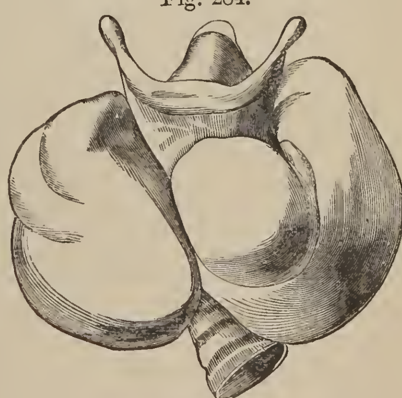
Scrofula.

Prof. Aitken[1] defines scrofulosis and tuberculosis as the same diathesis. This identity is now denied by many pathologists. A distinction is at present generally drawn between the *caseous* matter of softened glands and *true tubercles*. Yet certain phenomena justify the use of the term strumous or scrofulous diathesis. "These phenomena are associated with peculiarities of outward appearance during life, and liability to certain diseases termed scrofulous, such as swellings of lymphatic glands and of joints, carious ulcerations of bones, frequent and chronic ulcerations of the cornea, ophthalmia, abscesses and cutaneous pustular eruptions, persistent swelling and catarrh of the mucous membrane of the nose, and characteristic thickening and swelling of the upper lip—lesions which, while they are distinguished by mildness of symptoms, are peculiarly persistent, and follow the application of exciting causes which would have no effect on a healthy person."

SCROFULA is the term applied commonly to those of the above named local affections involving (most frequently in rather early life) the glands, bones, nose, ears, and eyes. *Goitre* or *bronchocele* (enlargement of the thyroid gland in the neck) is an analogous if not identical affection. It is most common in narrow, damp valleys of the Alps and other mountainous regions.

The CAUSES of Scrofula are, chiefly, *hereditary transmission* and *deprivation of pure air*. The former is well known to all. Baudelocque, McCormack, and Greenhow, among others, have proved the latter most thoroughly. All depression of the system by low living, such as insufficiency of food and warmth, etc., will promote it. It has been imagined, not proved, that the syphilitic taint of constitution may glide into it.

Fig. 284.



GOITRE.

In TREATMENT of scrofula, in any of its forms, but particularly in chronic enlargements, with or without cheesy softening, of the lymphatic glands (of the

[1] Science and Practice of Medicine, vol. ii. p. 188.

neck, armpit, or groin), iodine has general confidence. It is not, however, infallible. Iodide of ammonium (dose 3 grains) is now coming under trial. The external application of iodine to tumors, scrofulous or other, "to produce absorption," will very frequently disappoint. It is not certain that it has, locally, any effect but as a stimulant or irritant. That may sometimes be useful.

Cod-liver oil is also an anti-strumous remedy of great power; and it is more readily taken by the young than by adults, generally. Iron may be serviceable in many debilitated scrofulous cases. Sea bathing and sea air are mostly the best of remedies. Good diet is indispensable.

The *local* treatment of so-called scrofulous affections is to a great extent surgical. Slowly softening glands may sometimes be cut out. Scrofulous periostitis, threatening caries, has been arrested by free application of *cerate of carbonate of lead* over the affected bone. The leg is most frequently the seat of such disease; but it may attack any of the long bones. Removal of diseased or necrosed portions is to be recommended rarely, unless they are *loosened*. Extensive resections should be very exceptional.

Rickets.

SYNONYM.—*Rachitis*. Infants upon learning to walk show the cachexia to which this name is given, by yielding of the bones, with muscular debility, and general failure of nutrition. The bones are brittle from imperfect development; the spine is apt to become curved, and the limbs crooked. The teeth are backward in coming, and fall out with early decay. Tenderness of the surface of the body, and irritability of the nervous system, also exist.

TREATMENT.—*Hygienic* measures are of the first consequence. Well-aired rooms, warm salt bathing, milk or beef-tea diet, cod-liver oil, iron, and phosphate or hypophosphite of calcium, all have their value.

Anæmia.

DEFINITION.—Poverty of blood.

The CAUSES of anæmia are, most often, either—1. Loss of blood, from disease or injury causing hemorrhage. 2. Excessive suckling in a mother or wet-nurse. 3. Severe or protracted diarrhœa, or (more rarely) leucorrhœa. 4. Typhoid or other forms of fever. 5. The malarial influence, sustained for a considerable time. 6. Deficiency of food, light, warmth, or fresh air.

Anæmic SYMPTOMS are, pallor, slenderness of figure, debility, nervous excitability, cardiac palpitation.

In the TREATMENT of anæmia, *good diet*, *pure air*, and *iron* or cod-liver oil are the essentials. Of the preparations of iron, numerous as they are, we may find the most satisfactory results from the tincture of the chloride, the pill of the carbonate (Valleix's mass), the iodide (syrupus ferri iodidi), the phosphate, and, in children, the citrate. Dr. Aitken speaks very highly of the value of a combination designated as the "syrup of the phosphates of iron, quinine, and strychnia." Beef, iron, and wine are now often given together in a pharmaceutical preparation.

Leucocythæmia.

DEFINITION.—White-cell blood.

The history of its discovery, which has been subject to controversy, appears to be, in brief, as follows. Dr. Craigie, of Scotland, reported (1845) a case of disease of the spleen, examined also by Dr. John Reid, in which a peculiar appearance of the blood occurred, supposed by them to be "purulent." Dr. Bennett, of Edinburgh, in 1845, published an account of a similar case, describing it as "suppuration of the blood." A month later, Virchow, of Berlin, described a case, presenting the same appearances, under the microscope, as *leukæmia*, or white blood, asserting the view that excess of the colorless corpuscles, *not* suppuration, was the true nature of the affection.

The CAUSES of leucocythæmia are, exposure to cold and wet, prostrating diseases, such as typhus, typhoid, or puerperal fever, and affections of the lymphatic glands or of the spleen, often of undetermined origin.

Its SYMPTOMS are, debility, swelling of the abdomen, anasarca, often vomiting or diarrhœa, jaundice, and hemorrhages from the nose or gums. The spleen, and sometimes the liver, are enlarged. The lymphatic glands are often so, also. Cough may occur; and so may pustular eruptions. The tendency of the disease is towards death, and it is doubtful whether any case, well marked, has been cured. But it is slow, and may extend over many years.

DIAGNOSIS of leucocythæmia is only possible by microscopic examination of the blood. A drop from a needle prick of a finger will suffice; placed under a miscroscope of 250 diameters or more. Instead of being but one to fifty or more of the red corpuscles, the white blood-cells may be one to six or four; perhaps even one to two or three. When a larger quantity of blood is drawn, it has, after heating, a whitish or milky look. Its coagulum is grayish-white on its surface, from excess of the colorless corpuscles. After death, coagula are found in the heart, consisting of such corpuscles almost alone.

We have said that the *cure* of leucocythæmia has not yet followed any of the many remedies tried for it. No doubt life may be prolonged under it, by hygienic management, and tonics. Nitric and nitro-muriatic acids are recommended; the latter by the bath as well as internally.

Pyæmia.

"Absorption of *pus*," as such, through the walls of bloodvessels, was formerly believed to be impossible on account of its cellular nature, the pus cells being too large to pass through the capillaries. The observations of Cohnheim and others, on the escape of leucocytes (white blood corpuscles) through the walls of the capillaries during inflammation, have modified this view somewhat. Under the name pyæmia, indeed, several affections are included. 1. *Septicæmia* or *ichorhæmia*, *i. e.*, blood-contamination from absorption, in a liquid state, of putrescent or otherwise morbific material; 2. Transfer by veins of actual pus, in cases of phlebitis, and its deposit in new localities; 3. *Thrombosis*, or coagulation in

a vein during life, followed by *embolism*, or the conveyance of a portion or portions of coagulum to different parts, causing irritation or obstruction.

That inflammation of a vein (phlebitis) does not very unfrequently occur, there is no doubt. But the external coat and surrounding connective tissue are generally most involved; and suppuration of its internal lining is rare. Coagulation is much more frequent. Embolism, however, as well as thrombosis, may, and often does, take place, without any of those general symptoms to which the name of "purulent infection" is given. Most properly, the name pyæmia should be restricted to cases in which, to cite the words of J. Simon, "some diseased part (which need not be an external wound) so affects the blood circulating through it, that this blood afterwards excites destructive suppuration in parts to which the circulation carries it—namely, commonly first in the lungs, or (in certain cases) liver and lungs, and later generally about the body." Putrid infection, septicæmia or ichorhæmia, may occur without local suppurations, but with symptoms otherwise similar. Clinical convenience may readily excuse the designation, common with many, of such cases, by the same term, pyæmia.

SYMPTOMS of such an affection are chills, low fever, rapidity and feebleness of the pulse, prostration, delirium, and swelling of the joints. Death may occur in a few days, from devitalization of the blood; or, if purulent formations occur, by exhaustion caused by their presence and discharge.

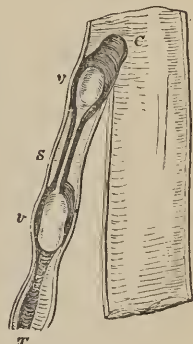
In the TREATMENT of pyæmia or septicæmia, support and depuration of the blood are the indications. *Pure air* is not only preventive, but positively curative of such affections. Of medicines, the attention of the profession has been especially called to carbolic acid, and the sulphites and hyposulphites of sodium, calcium and magnesium, proposed by Prof. Polli, of Milan, as antiseptic remedies. Several favorable cases of their use are reported; although, in the U. S. army, during the late war, disappointment was experienced by a number of those who employed them. Sulphite of sodium may be given safely to the extent of four or five drachms daily; the bisulphite (Wood), about half as much, or less. It is certainly proper to give these remedies a fair and prolonged trial.

Embolism.

Cruveilhier, many years ago, proved that in inflamed veins a clot is formed, principally fibrinous. Gulliver ascertained that a granular degeneration of the central layers of such a coagulum may occur, giving a "puriform" character to their substance. Virchow then demonstrated that portions of such clots may be carried from their first seat in the circulation, and form *plugs* in the pulmonary or some other artery. Afterwards it was shown (Paget, Druitt, Kirkes, Goodfellow, etc.) that not only *thrombosis* in veins, with or without inflammation, but also inflammatory or degenerative deposits on the heart's valves, may give off *emboli* or floating masses, which may obstruct the arteries of the lungs, liver, brain, or other organs, causing atrophy, or irritation and inflammation. The septic degeneration of the debris of such clots may also contaminate the blood—causing septicæmia and ichorhæmia.

Emboli are, apart from their origin, chiefly *arterial* or *venous* in their locality. The arteries most often so obstructed are, those at the base of the brain, the internal carotids, the femoral, brachial, splenic, renal, external carotid, and mesenteric arteries. One obstruction is apt to be the source of others. Cessation of the pulse of the arteries in a limb is an early positive sign. Gangrene is usually the last and fatal event if an extremity be involved.

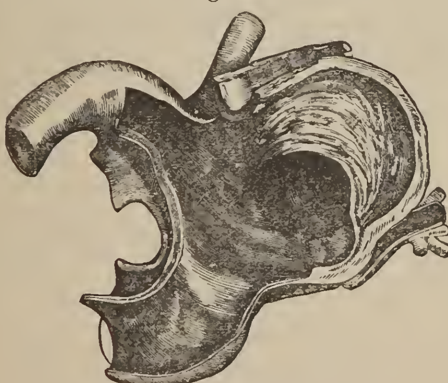
Fig. 285.



THROMBUS IN THE SAPHENOUS VEIN.

When the right half of the heart has received an embolus, and the pulmonary artery is obstructed, collapse of the lungs, partial or entire, follows. Pleurisy, hemorrhage, or bronchitis may occur also. Or, the symptoms may be, great anxiety and dyspnœa, with reduction of the temperature of the body. A systolic murmur may be heard on auscultation; the rhythm of the heart becomes irregular; and pulsation of the jugular veins may be noticed. Giddiness may be present, with blueness and œdema of the hands, feet, or both. Death occurs in much the greater number of cases of embolism.

Fig. 286.



EMBOLUS IN PULMONARY ARTERY.

Where emboli have become broken up and decomposed, septicæmia results—commonly known as pyæmia; as before explained. The temperature in this disease is commonly high; from 106° to 107° in the evening exacerbation.

For TREATMENT of embolism, without septicæmia, our only re-

sources are, *rest*, *support* by food and stimulants, and alleviation of nervous disturbance by opiates.

Addison's Disease.

SYNONYM.—*Melasma Supra-renalis.* Hardly any clinical association of morbid changes is more obscure in its pathology than this. A bronze-like discloration of the skin comes on gradually, preceded and accompanied by symptoms of anæmia and debility (muscular weakness, feebleness of the heart's impulse and pulse at the wrist, short breath upon exercise, impaired digestion, sometimes dimness of vision); after lasting from less than one year to four or five years, death occurs, and the only characteristic lesions are found to affect the supra-renal capsules.

It is manifestly a *cachexia.* Probably both the supra-renal capsular disease and the affection of the skin (olive-greenish darkening, mulatto-like, or like bronze without the gloss) depend upon the constitutional state. Perhaps caries of the vertebræ (scrofulous), which has been sometimes observed, may, by involving the *ganglia* in disease, thus produce the complex errors of nutrition, superficial and general. Dr. Wilks describes the appearances of the supra-renal capsule as resembling those of scrofulous lymphatic glands; a lardaceous material being deposited, which afterwards softens into a putty-like mass (grayish translucent material with yellow cheesy nodules), or undergoes drying into a chalky concretion. The disease is fatal always, at last. Besides hygienic management, and perhaps iron or other tonics, little treatment is recommended for it. Dr. Greenhow asserts decided advantage to have followed the use of a combination of glycerin, in two-drachm doses, with fifteen or twenty minims each of spirit of chloroform and tincture of chloride of iron.

CHAPTER III.

AFFECTIONS OF THE ORGANS OF DIGESTION.

Stomatitis.

DEFINITION.—Inflammatory disease of the mouth.

VARIETIES.—1. Simple stomatitis. 2. Aphthæ. 3. Thrush. 4. Inflamed ulcer or cancrum oris. 5. Gangrene of the mouth. 6. Mercurial sore mouth or salivation. 7. Nursing sore mouth. 8. Scorbutic disease of the mouth.

Simple Stomatitis.—From taking very hot or corrosive liquids into the mouth, it may become inflamed; this condition being shown by redness, swelling, soreness and heat of the tongue, gums, lining membrane of the cheeks, palate, and fauces. Corrosives (as sulphuric acid or creasote) may *whiten* the mucous membrane superficially.

TREATMENT.—In the beginning, holding ice, iced gum-water, or flaxseed tea frequently in the mouth, or if a corrosive agent be the cause, almond oil or dilute glycerin, will soothe the irritation. In violent glossitis, leeches may be applied to the swollen tongue; even free *incisions* may be called for to relieve its swelling; later, solution of alum or sulphate of zinc may be used as a wash. Remember that such articles ought not to remain long in contact with the teeth, the enamel of which they may impair.

Follicular inflammation of the mouth is recognized by small red elevations over the tongue, soft palate, etc. This is common in infants during dentition; as well as in adults of impaired general health. It requires no speciality of treatment.

Aphthæ.—These are small ulcers, with whitish surfaces, following a vesicular eruptive inflammation of the mouth. The vesicles are small, round or oval, of a pearly appearance, and contain serum. They break in a few days, leaving a sore white ulcer, with redness around it. They may be scattered or confluent. Fever may attend the latter, with disorder of the stomach. Though not common in the earliest infancy, children sometimes have this disease, but less often than adults. Decayed teeth may produce it. On the whole, it is to be considered rare. Its duration is generally a week or two, but confluent cases may last a month, and have occasionally been fatal.

TREATMENT.—The constitutional condition may require cooling laxatives or saline diaphoretics, and gastric irritation may call for antacids, as bicarbonate of sodium or magnesium. Chlorate of potassium should be given, 5 to 20 grains four times daily. Locally, at first, flaxseed-tea or gum-water, or a solution of glycerin in rose-water, may be frequently applied. When ulceration occurs, a powder, consisting of equal parts of prepared chalk and pulverized gum Arabic, may be dusted or laid over each of the ulcers, several times a day. A wash of borax, myrrh, alum, sulphate of zinc, or acetate of lead, may also be applied. If the ulcers prove severe or obstinate, strong solutions of sulphate of zinc (15 grains in f℥j of water) or nitrate of silver (20 grains in f℥j), or solid sulphate of copper, may be used to touch the ulcerated surface every day or two.

Thrush; Muguet.—This is much most frequent in infancy. Its peculiarity is, the occurrence, after a day or two of diffused inflammation, of a number of small whitish points within the mouth, which coalesce and form patches of a whitish curd-like exudation (often confounded with *aphthæ*). In bad cases it may become brownish. This may fall off and be renewed, more than once. The mouth is hot, the stomach disordered; vomiting and diarrhœa may occur, with some fever. The attack lasts from one to two or three or more weeks; being seldom dangerous except in children otherwise in poor health. It sometimes attacks adults.

NATURE.—The specific nature of the curd-like exudation appears to be connected with a *microphytic* (minute vegetative) growth, to which the name of *oidium albicans* has been given.

TREATMENT.—Experience favors the internal administration of *chlorate of potassium* in all severe forms of sore mouth. A child under five years of age may take from one to five grains of the

chlorate, in solution, several times daily. As a laxative, magnesia will be suitable. Feeble cases may require quinine, beef-tea, brandy, and milk, in quantities proportioned to their condition and age.

Cancrum Oris.—Canker of the mouth is characteristically ulcerative, from the commencement. It begins on the cheeks, gums, or lining of the lips; but may reach the fauces. The ulcer is grayish or yellowish-white, with an inflamed border and environs; the cheek may swell from it externally. It is quite painful. Saliva flows freely, and the odor of the breath is offensive. Fever is often present. The complaint may last for several weeks or even months; but is almost never fatal. It is most common in children, from two to six years of age.

TREATMENT.—Besides general measures, *adapted to the condition of the patient*, the same local applications mentioned as appropriate in different forms of sore mouth, may be used. Direct touching of the ulcer with a strong solution of sulphate of zinc (gr. xv vel xx in f℥j), or with the solid blue stone (sulphate of copper) twice daily, will do the most for its cure; especially with the intermediate "dressing" of powder of chalk and gum Arabic, and occasional washing with glycerin and rose-water.

Gangræna Oris.—Extreme inflammation or ulceration, in the mouth as elsewhere, may end in gangrene; but this affection is peculiar, and may be unconnected with any severe inflammation. A morbid state of the system seems to predispose to it. It occurs mostly in children, but has been met with in adults.

There is, at first, an ash-colored ulcer, most often on the gums or inside of the cheek. If the latter, it is accompanied by swelling. Spreading, it assumes a sloughing character; the breath grows fetid; acrid fluid is discharged, with copious salivation; other like ulcerations are formed, the bones of the face are affected with necrosis, and the teeth fall out. Penetrating the cheek, mortification may go on, rapidly, reaching sometimes even the ethmoid bone. Low fever and prostration attend these local changes; later, diarrhœa, colliquative perspirations, and death. The only well-marked promotive *causes* of this very serious disease are, bad air (especially *crowd-poison*) and insufficiency of food. When treated early, it is often quite manageable; but after extensive sloughing has occurred, the prognosis is bad.

TREATMENT.—Early, always try the chlorate of potassium. Quinine, and tincture of chloride of iron will be required on account of the tendency to prostration. Beef-tea and wine whey, or brandy or whisky-punch, *pro re nata*, are called for, by the same indication.

To the part, at first, the astringent lotions, mentioned already, may be applied. When the gangrenous condition becomes pronounced, a solution of liquor sodæ chlorinat. in glycerin (fʒj in f℥ij) may be applied frequently. Solution of creasote in glycerin, or in water (gtt. iij to gtt. xx in f℥j) may meet the same purpose; or permanganate of potassium (gr. x in f℥j); or chloride of zinc (gr. j in f℥j); or sulphite of sodium (℥j in f℥j); or bromine (ʒss in f℥ij).

Mercurial Sore Mouth.—Salivation is made known in its approach

by a "coppery" taste, soreness of the gums, tenderness of the teeth when pressed together, with redness and swelling of the gums, and a broad white line just beyond their edge. The tongue also may swell. The flow of saliva increases greatly; the cheeks and even throat may grow sore and painful; the breath offensive. Ulceration of the gums takes place in severe cases, with loss of the teeth. Even sloughing may follow, approaching the state of things in *gangræna oris*. Difficulty of swallowing may be so great as to threaten starvation; and irritative fever may result from the local disorder.

Treatment.—Moderate salivation will always pass away in a few days, spontaneously. A good mouth-wash for it is brandy and water, one part of the former to four of the latter; alum may be added to this, or a little tincture of myrrh. Ulcers or sloughs should be treated as in other varieties of stomatitis.

Opium may be called for, at least at night (*e. g.*, Dover's powder, 10 grains at bedtime), by the distress of the system. Milk diet, or some other liquid nourishment, must be given during the difficulty of deglutition. In good practice, at the present day, no physician ever seriously salivates a patient.

Nurses' Sore Mouth.—Women who suckle children, and sometimes those who are advanced in pregnancy, are liable to ulcerative stomatitis. It begins with small, hard, painful swellings on the tongue and cheeks, which ulcerate, and are attended by a great deal of local, and sometimes constitutional irritation. When the infant is weaned, the affection subsides soon.

Treatment.—Chlorate of potassium has in this complaint a special curative power. Twenty grains of it may be given three or four times daily. Iron, quinine, etc., may be required in subjects of obvious debility. Local treatment, such as has been given for *cancrum oris*, etc., will also have its utility.

Tonsillitis.

When severe, this is commonly known as *quinsy*. Soreness of the throat in swallowing, with pain or swelling of one or both tonsils, and fever, are its symptoms. Unless relieved in a few days, the pain becomes very constant and throbbing, dysphagia extreme; and when the patient begins to be seriously alarmed, a tonsillar abscess breaks, or is opened by the physician, and recovery soon follows.

Treatment.—A dose of citrate or sulphate of magnesium, or some other cooling aperient, should be given the first day. Then, wine of ipecac., twenty drops every three hours, with frequent draughts of flaxseed tea or flaxseed lemonade. Poultice with flaxseed meal to which lard and laudanum have been added; bathing, when the poultice is changed, with liniment of ammonia, or soap liniment to which aqua ammoniæ has been added. If still severe, and not certainly suppurating, a *small* blister may be applied, or the part may be painted with tincture of iodine. When an abscess is evidently forming, poultices will be better, until it is ready to open from within.

Lancing the suppurated tonsil requires care, not to open the

internal carotid artery. The point of the lancet should be directed towards the middle, not the outside, of the throat.

Not unfrequently, especially in children, repeated attacks of non-suppurating inflammation of the tonsils will leave them inconveniently enlarged. Sometimes, the persevering use of astringent gargles, or touching daily with strong solution of tannin or nitrate of silver, will make them shrink to the normal size. If not, excision of a part of the tonsil may be proper. With Fahnestock's, or any other guillotining instrument, the operation is easy and safe; at all events if it be not attempted to remove the whole gland, which is not necessary.

Pharyngitis.

Slight sore throat is among the commonest of affections, requiring for its treatment only mild gargles (as alum in flaxseed or sage tea), demulcents (flaxseed or gum arabic or slippery elm infusion), fomentation with volatile liniment or spirits of turpentine, and a dose of a saline cathartic, with *slop* diet. With children who cannot gargle, finely powdered alum may be blown into the fauces and throat, through a quill, more readily than in any other way.

Chronic pharyngitis is often a much more troublesome, though not dangerous local disorder. The mucous membrane becomes permanently hyperæmic, almost granulated; with either abnormal dryness or a thickened secretion; and constant soreness. In the treatment of this, all the different astringent, demulcent and alterative applications may be tried—sometimes without success. When nitrate of silver, tannin, sulphuric and muriatic acid, sulphate of zinc, and acetate of lead have been found to fail, it may happen that ice, or gargling often with ice-water, will prove more useful.

Counter-irritation, with repeated small blisters, tincture of iodine, or croton oil, is always a suitable and important part of the treatment of chronic inflammation of the throat.

Ulcerated Sore-throat.—This may be idiopathic, syphilitic, or tuberculous. The former is most uncommon.

The treatment in the first variety consists of the local application of blue stone or, lightly touched, solid nitrate of silver to the ulcers if within reach. The syphilitic will require, also, iodide of potassium internally (gr. v vel x ter die); the tuberculous, tonics, generous diet, and cod-liver oil.

Retropharyngeal Abscess.

This most often follows fever as a sequela; but is altogether rare. It is shown to the careful observer by dysphagia and dyspnœa, much increased by the recumbent posture; yet not, as in croup, increasing from day to day, or disappearing in a short time. There is also stiffness of the neck, and swelling on one or both sides of it. In such circumstances, a finger passed over the tongue into the pharynx may find a firm projecting tumor occupying its posterior and lateral walls. It may prove fatal, by asphyxia, or by preventing the patient from swallowing food. When diag-

nosticated in time, the matter may be let out by opening the abscess with a lancet, through the pharyngeal wall.

Stricture of the Œsophagus.

This is uncommon. Its principal causes are, if structural, corrosive poisons, swallowed; or ulceration of the throat involving the œsophagus, and contracting upon cicatrization. Functional stricture may be spasmodic, as in hysteria. Dysphagia, not otherwise accounted for, and obviously low down in its seat, or the rejection of food partly swallowed, may lead to a suspicion of stricture; and examination with a bougie will fix the diagnosis. For the structural affection, there is no appropriate treatment except dilatation with bougies made for the purpose, applied for a short period, oiled, once or more daily.

Fig. 287

STRICTURE OF THE ŒSOPHAGUS.

Gastritis.

Simple gastritis, in an acute form, is very rare. Corrosive poisons almost always involve the intestinal tube with the stomach. The most common form of "idiopathic" gastric inflammation is "gastro-hepatic catarrh," or a "bilious attack," in which the stomach, duodenum, and liver are somewhat involved.

Signs of stomachic inflammation are, epigastric pain and tenderness on pressure, rejection of all food and drink, jactitation, and fever; the pulse, however, being kept down by the impression made upon the circulation by constant nausea.

Post-mortem evidences of gastritis are—redness, browner or deeper and more livid than natural, and dotted, stellated or arborescent, rather than diffused; moreover, not confined to dependent parts; enlargement of bloodvessels; in acute cases, softening of the mucous membrane: in more lengthened ones, either softening or hardening and thickening; abundance of thickened mucus; rarely, coagulable lymph; almost never, pus.

Gastro-hepatic catarrh may follow any of the causes of indigestion, or exposure to cold and wet. There is nausea, or vomiting of greenish-yellow fluid, generally not copious, but very acrid; headache and dizziness; constipation of the bowels, and fever. In the treatment of this, *magnesia* is a good quieting stomachic and cathartic; many will be relieved as soon by a bottle of solution of citrate of magnesium. Ice, melted in the mouth and swal-

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lowed slowly, will be comfortable. Rest and abstinence from food as nearly as possible will, with the above, generally complete the cure in two or three, or not many more days.

The commonly used *preventive* or *abortive* of "bilious attacks" is *blue pill*, early administered. Let the first nausea, constipation, and headache, be met by giving at bedtime two or three grains of blue mass in pill, followed in the morning by a teaspoonful or two of Husband's magnesia. If the bowels are free, bicarbonate of sodium will be better; the eighth part of a teaspoonful at a dose.

Sick headache is usually a modification of the above, in so far as the sympathetic cephalalgia is especially severe. In some persons it is periodic. The treatment above mentioned will be adapted to a majority of cases of it.

Acute softening of the stomach is described by a few French and other writers, as a rapidly prostrating and dangerous affection in children, sometimes epidemic. Its symptoms are said to be, at first, those of simple gastritis; then, with or without diarrhœa, great agitation, prostration, want of sleep, and insensibility—and death in one or two weeks from exhaustion. An irregular fever with gastric irritation (gastric fever or infantile remittent) once had a regular place in the nosological catalogue among fevers. It appears to be scarcely uniform enough for so special a designation or consideration.

Chronic Gastritis.

While the same doubt as to the pathological correctness of the *name* (indicating inflammation) exists in the case of this disease as in other "chronic inflammations," an affection of some distinctness of character, commonly called by the above title, is often observed. With the greatest brevity, we may indicate its symptomatology by contrasting it with that of *atonic dyspepsia*.

In Chronic Gastritis.	In Atonic Dyspepsia.
Much epigastric tenderness.	Little or no epigastric tenderness.
Pain increased by active exercise or stimulating food.	Pain not increased by exercise, lessened by stimulating food.
Vomiting usually.	Vomiting rarely.
Eructation of gas rarely.	Eructation of gas commonly.

Chronic gastritis is apt to be obstinate but not dangerous to life.

Treatment.—Counter-irritation over the epigastrium, by repeated vesication, will be useful. Internally, *nitrate of silver*, in pill, beginning with gr. $\frac{1}{4}$, with gr. $\frac{1}{8}$ of opium, and increasing in a few days or a week, gradually rising to 1 gr. thrice daily, with a proportionate quantity of opium, is a valuable medicine. Subnitrate of bismuth is, for the same condition, lauded by some. Most important is a *bland diet;* lime-water and milk, arrowroot, tapioca, sago, jellies, cracker soaked in ice-water, etc., in small quantities at short intervals. Ice will often quench thirst to better advantage, without disturbing the stomach, than water.

Ulcer of the Stomach.

This serious affection is rare after the middle of life. It is most often met with in feeble systems, especially in women.

Symptoms.—Dull, sickening pain in the stomach, extending to the back, with *localized* tenderness on pressure. The pain is increased by motion, and by food, especially by *hot* food, or by sugar. Vomiting occurs, not copious, but rather frequent. Vomiting of *blood* is an important sign; it is impossible to be certain of the existence of an ulcer in the stomach without it. The amount of blood thrown up at once may be very small.

It is often difficult to diagnosticate gastric ulcer from *chronic gastritis*, as well as from *cancer*, *caries of the spine*, and *aortic aneurism.* No hæmatemesis, however, is met with in the first, third, and last; and a tumor, at some period, will make known cancer. So will angular deformity demonstrate spinal caries.

Perforation, causing peritonitis, and copious hemorrhage, are the most dangerous terminations of gastric ulcer. The signs of the former are, abdominal swelling and diffused pain, with collapse.

Fig. 288.

Perforating Ulcer of the Stomach.

Treatment.—Bland diet is very important. Arrowroot, tapioca, sago, corn starch, rice, and lime-water and milk are suitable. Beef or mutton tea (concentrated) will be better for the feeble than solid food.

Nitrate of silver, in pill with opium; oxide of silver, in 1 or 2 grain doses; and subnitrate of bismuth, are given with the hope of promoting cicatrization of the ulcer. Opium alone, in pill, or laudanum, etc., or conium or belladonna, as anodynes when the pain is severe. When hemorrhage is threatened, creasote ($\frac{1}{2}$ drop to 2 drops), tannin, acetate of lead, oil of turpentine (small doses), ammonio-ferric alum. Hypodermic injection of morphia has been used with advantage for the gastric irritation.

Cancer of the Stomach.

Scirrhus of the *pylorus* is the most common form; occasionally the cardiac orifice is the seat of cancer. The usual symptoms are pain (in rare instances absent or nearly so), often excruciating; epigastric tenderness, about in proportion to the pain; vomiting of food, mucus, and "coffee-grounds," or mixed blood and mucus, almost never pure blood; acidity and other symptoms of indigestion; fetid breath; decided constipation; emaciation and cachectic, almost jaundiced, sallowness of complexion; sometimes irritative fever. The diagnosis is made nearly certain by the discovery of a tumor; not absolutely so—as the tumor may be fibroid and not malignant.

Cancer of the stomach seldom occurs before forty years of age. Its duration averages about a year; it seldom reaches two years.

The patient commonly dies by a slow starvation, the stomach becoming incapable of digesting and transmitting food.

No treatment can avail for the *cure* of such an affection. To nourish by concentrated articles of diet, as beef-tea, milk, etc., and to allay suffering by judicious use of anodynes, will be all that we can do. It is a frequent form of cancer.

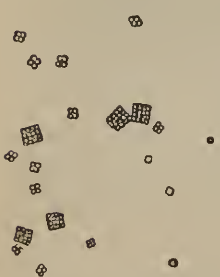
Cancer of the Duodenum, Cæcum, Rectum, and *Omentum* are much more rarely met with. Their possibility must always be remembered in considering the diagnosis of abdominal tumors.

Dyspepsia.

Although denied a special place in nosology by writers upon diagnosis, clinical experience calls for a separate recognition of this as a disease, complex as its pathology is, and diverse as may be its symptoms. Of the latter, only a very general account can be here given.

SYMPTOMS.—The patient *feels* his stomach all the time, though not nearly always with pain. When the latter occurs, it is often in the breast, causing suspicion of pectoral disease. Little or no tenderness on pressure exists, nor is there much nausea, nor vomiting. The mouth is clammy, or has a sour or bitter taste. The complexion is sallow. The bowels are costive, and stools deficient in color. Other frequent symptomatic affections are cardialgia (heartburn), pyrosis (waterbrash), hypochondriasis, palpitation of the heart, headache, and disorders of the senses, as diplopia (seeing double), etc. Dyspepsia is not a dangerous, but is frequently a very obstinate disease.

Fig. 289.



SARCINÆ, FROM THE STOMACH.

PATHOLOGY.—The functional disturbances above enumerated have their seat more or less prominently in different parts of the digestive apparatus; in the alimentary mucous membrane, glandular organs, or muscular, or ganglio-nervous. The distressing gastro-intestinal irritation, cardialgia, pyrosis, etc., are located in the mucous membrane. Defective action of the liver and enteric glands produces constipation, with its consequences; imperfect secretion of the gastric juice and pancreatic secretion, like hepatic inaction, impairs the whole process of digestion. So does atony of the muscular coat of the stomach; while deficient power of the peristaltic intestinal contraction is perhaps the most *common* cause of constipation. Insufficient or perverted *innervation* may originate or intensify any or all of these morbid states and actions. Sometimes this is so obviously primary and predominant, as to justify the use, in certain cases, of the term "nervous dyspepsia."

CAUSATION.—Most briefly, we may assert the causes of dyspepsia to be, either one or several of the following: too much food, or too little food; imperfect mastication, and hurry in eating; too little exercise; too much fatigue; excessive study, or emotion of

mind; inordinate use of ardent spirits, opium, tobacco, coffee; or of medicine out of place.

TREATMENT.—This involves *regimen*, as well as medication: the first is most important. The meals should be regular, and with sufficient time allowed; and all the food should be simple as well as nutritious; variety being obtained rather by having a change from day to day, than by a number of dishes at each meal. Some dyspeptics are obliged to eschew variety, and confine themselves to a routine of beef, mutton, and stale bread. Caution should be used not to blame, unjustly, particular articles as "disagreeing," when everything disagrees, because of the state of the stomach. But a sensible person will be able mostly to ascertain what things agree *best* with his digestion; and others should not be taken.

Exercise, daily, in the open air, is very important to the dyspeptic. So is bathing; to maintain healthy action of the skin, with which the stomach sympathizes. But active exercise ought not to be taken just before or after a meal.

Mental states, and nervous impressions, are also of great consequence. Anxious occupation, or harassing responsibility, may increase greatly the difficulty of recovery. Thus travelling, or resorting to watering places, with release from care, may assist the cure.

The *medical* treatment of dyspepsia involves a number of indications, not always exactly the same. Especially are *tonics*, *laxatives*, *antacids*, and other palliatives, and alteratives, apt to be required.

Tonics.—Pure vegetable bitters, as gentian, quassia, and columbo, are most suitable as direct stomachics. Chiretta is a favorite with some. Oxide of silver has had one or two enthusiastic advocates. Where *nervous debility* is prominent, and particularly in cases of long standing, extract of nux vomica, or strychnia in very small doses (one-fortieth to one-thirtieth of a grain) will often do more good than any other medicine. Iodide of iron, in anæmic cases, may be given.

Laxatives.—Rhubarb has been, time out of mind, the stand-by for habitual constipation. If it be insufficient alone, or lose its effect, compound extract of colocynth, aloes, or resina podophylli may be added in pill. Senna, magnesia, and sulphur may be used occasionally, for special indications. Saratoga, Cheltenham, and Vichy waters are found sometimes to have excellent effects.

Antacids.—After meals, a pinch of bicarbonate of sodium (gr. v to gr. x) or half as much bicarbonate of potassium, or a dessertspoonful of lime-water, will, in case of acidity, contribute much to the comfort of the patient. Carbonate of magnesium and aromatic spirit of ammonia are preferred by some; and charcoal has useful absorbent powers. Sulphite and hyposulphite of calcium or sodium, for antiseptic effect, may also be given to allay the after symptoms of indigestion.

Alteratives.—In the commencement of the treatment of a case of dyspepsia, in which derangement, and commonly inaction, of the liver is most generally present, experience justifies the moderate use of blue pill. It may be given in fractional doses, in such a case, say gr. $\frac{1}{4}$ thrice daily for a week. Occasionally it may require

to be repeated, at intervals; but should never be pushed to salivation. Nitro-muriatic acid, in 3 or 4 drop doses, acts as a mild tonic both to the stomach and to the liver; and may well follow blue mass, where hepatic torpor is believed to exist. The same indication may be met, although with less certainty, by taraxacum. Nitric acid (2 or 3 drop doses) is highly lauded as a tonic by some practitioners.

Cardialgia seems to depend mainly upon acidity, aggravated perhaps by the butyric fermentation. Aromatic spirit of ammonia, tincture of ginger, and camphor water, as well as the antacids above named, may be given for it; or chloroform, in 5 or 10 drop doses.

Gastrodynia is a technical term for stomach-ache, common in dyspeptics. Carminatives are appropriate for it; one of the best of these is oil of cajuput, 4 drops at a dose, on a lump of sugar. Spirits of camphor, compound spirits of lavender, compound tincture of cardamom, and essence of ginger are among the most popular preparations for its relief. A mouthful of very hot water will sometimes quell the pain.

Pyrosis is best treated by mild astringents; as oil of amber, catechu, krameria, ammonio-ferric alum, creasote (½ drop or ¼ drop doses), tincture of chloride of iron.

Dr. Brown-Séquard has lately (1873) proposed, for aggravated cases of dyspepsia, treatment by very frequent small portions of food, in an easily digested condition. This plan has not yet been extensively tried.

Enteritis.

DEFINITION.—Inflammation of the bowels.

SYMPTOMS.—Pain in a portion of the abdomen, increased by motion or pressure; constipation; fever. Later, abdominal swelling, vomiting, and mucous, sanguinolent, or even purulent diarrhœa, in bad cases.

CAUSES.—Blows or other injuries; neglected constipation; exposure to cold and wet. Corrosive poisons, as arsenic, etc., also cause enteric inflammation; and it is a part of the results of strangulated hernia or other intestinal obstruction.

TREATMENT.—A decidedly open and active case may, according to some authorities, at least, require or bear early venesection in the robust. Leeching should be the rule; and it may be free. After that, poultices, of flaxseed meal or Indian mush, covered with oiled silk to retain moisture. Soft food alone can be taken, as arrowroot, oat-meal gruel, etc., or, in the weak, beef-tea. No medicine can do any good, unless it be opium in moderate doses, to relieve severe pain and promote rest. Cathartics are to be avoided, and entire repose of the body in bed must be maintained. From slight or moderate inflammation of the bowels recovery may be confidently expected, with care; but aggravated cases of it are frequently fatal.

Typhlitis is inflammation of the cæcum or caput coli. It is rather more common than other forms of enteritis, especially after neglected constipation. *Peri-typhlitis* is a more obscure affection, differing, perhaps, in involving a local or circumscribed peritoneal inflammation with typhlitis. Pain, tenderness, swelling, and dull

resonance on percussion in the right iliac fossa, with constipation, are the symptoms. With more especial propriety than in most other cases of enteritis, opening the bowels, by enemata at least, and even by a mild laxative, as castor oil, has seemed to be indicated. Rest, leeching, poulticing, and soft diet are the other main parts of the treatment.

Abscess may occur notwithstanding; with safe issue if it open outwardly, but fatal if it rupture into the peritoneal cavity.

Peritonitis.

Inflammation of the peritoneum is one of the most dangerous of the phlegmasiæ, because of the extent and important connections of the membrane involved.

VARIETIES.—Simple or idiopathic; accidental or traumatic; tubercular; puerperal.

CAUSES.—Exposure to cold and wet; falls, blows, wounds, or other injuries; abscess of the liver; opening of an aneurism, or perforation of gastric or intestinal ulcer (as in typhoid fever); tuberculization; the puerperal state.

SYMPTOMS.—Diffused abdominal pain and tenderness, increased greatly even by *slight* movements, as breathing deeply or raising the lower limbs in bed; vomiting; constipation; tympanites; fever, with *very rapid*, though not full pulse. Later, that is in three or four days, in violent cases, delirium, insomnia, collapse. Its course is usually rapid; from the incipient chill to the fatal end, often occupying less than a week, though sometimes two. Simple sporadic peritonitis, however, even in puerperal women, is, with careful treatment, much more often recovered from than not.

DIAGNOSIS.—The most important point is the discrimination of "simple peritonitis or metro-peritonitis in the puerperal state" from puerperal fever. The main difficulty about this is that the latter disease *includes* peritonitis almost as constantly as erysipelas does diffusive inflammation of the skin.

MORBID ANATOMY.—After death from peritonitis, the swollen abdomen is found nearly always to contain fluid, often considerable in amount, serous, sero-sanguinolent, sero-purulent, or pus. The latter may form in a few days; some facts have made it probable, even within forty-eight hours. *Adhesions* are present, with bands and false membranes of coagulable lymph, in various parts of the abdominal cavity; and redness, thickening, and opacity exist to a greater extent.

TREATMENT.—If venesection be ever admitted as a remedy, no disease bears better the early use of the lancet than acute peritonitis. One free bleeding may sometimes, as it were, arrest the conflagration. Yet, apart from epidemic puerperal fever, in which bleeding has, upon the amplest trial, proved rather destructive than curative, there are cases in which economy of material makes venesection unsafe. Then leeching may be resorted to, in all but very feeble subjects. Fifty or a hundred American leeches may be borne upon the abdomen by a patient who would faint if the same amount of blood were rapidly taken from a vein. Exposure of the body during leeching may be, with care, avoided. Poulticing with flaxseed or Indian meal should follow the leeching; the

poultices should be large, but light, and covered with oiled silk, or changed very frequently to maintain warmth. If no leeches have been used, flannel dipped in spirits of turpentine may be put all over the belly. Later, if the case threaten obstinacy, a large blister should be applied.

Of medicines, *opium* has the almost universal confidence of practitioners. Except emptying the rectum at first by mild enemata, no agitation of the bowels by medicine is to be encouraged. Calomel, as an *antiplastic*, has been long valued by physicians of sagacity and experience; although the number of its advocates for this use is now small.

With opium, then, we may, in peritonitis, give calomel: ½ grain to 1 grain of the former, with as much or less of the latter, every 2, 3, or 4 hours, according to the severity of the pain and the urgency of the case. When the stage of debility comes on—or in very feeble cases from the first—quinine, instead of calomel, may be combined with opium; and support with beef-tea, and wine, brandy, or whisky, may be required.

When peritonitis follows an *injury*, the treatment may necessarily have to be modified by the concomitant states of other organs involved, or by the general shock of the system. So, also, when perforation of an ulcer of the stomach or bowel, or the rupture of a hepatic or other abscess or aneurism, brings it on—*collapse* is apt to occur speedily, forbidding any but anodyne and supporting treatment, and affording very little hope under that. Such cases are almost invariably fatal.

Chronic peritonitis is sometimes met with. When not tuberculous, although a very serious affection, it may be recovered from; the tuberculous form, not with any more probability than pulmonary phthisis.

Chronic peritonitis should be treated by rest in the recumbent posture (in tedious cases the patient may be *carried* out into the sunshine and air), and resolvent and counter-irritant local applications; as repeated blisters, tincture of iodine, mercurial ointment, cerate of carbonate of lead. The latter, as a local sedative, has remarkable power. It may be prepared by adding ʒij of carbonate of lead to ℥j of fresh simple cerate.

Colic.

VARIETIES.—1. Flatulent. 2. Bilious. 3. Spasmodic, gouty, or rheumatic. 4. Lead colic. Some writers also speak of *nephritic* colic; the pain of which is chiefly owing to the passage of small calculi from the kidney to the ureter; while *neuralgia* of the bowels may also cause pain of similar seat to colic. *Uterine* colic in females, may be either neuralgic, spasmodic, or obstructive (dysmenorrhœa).

Flatulent Colic.—This is caused by indigestion; as from excess in the amount, or error in the quality of food; or, from cold and wet, arresting perspiration and disturbing the balance of the "aqueous visceral circulation," which is indispensable to normal digestion. Acrid *irritation* and gaseous distension produce irregular tonic or spasmodic contractions in the intestines; principally in the colon. They are not confined to this, however. Sometimes the stomach itself is the seat of pain.

In flatulent or crapulent colic the abdomen is distended, but not very tender, except after long continuance of the attack. There is constipation of the bowels; often nausea, with belching of wind, sometimes vomiting; no fever. A sign of the yielding of the attack is audible or palpable rumbling of wind in the bowels; showing a return of the almost arrested peristaltic motion.

Bilious Colic.—The onset in this form is slower. Nausea is greater, and vomiting, of greenish or yellowish (biliary) fluid, is constant. The pain may last, with very slight remission, for a number of days. The bowels are constipated. There may be considerable fever, and some tenderness of the abdomen on pressure. Meteorism is generally present; but less in proportion to the pain than in flatulent colic. In protracted cases, slight or moderate jaundice is quite common.

The greatest suffering in cases of bilious colic is attendant upon the passage of gall-stones from the gall-bladder to the duodenum. Then, the pain is chiefly in the right hypochondriac and lower part of the epigastric region; and sudden relief follows the escape of the calculus from the *ductus choledochus* into the intestinal canal. In other cases, we suppose that the irritant which gives rise to spasmodic pain is acrid, unhealthy bile; which escapes into the intestines, and also, through the pylorus, into the stomach.

Certain persons are particularly liable to such attacks; a large majority of people, indeed, are never subject to them. But prolonged bilious colic is never quite free from danger of inflammation of the bowels, or, in feeble persons, exhaustion from continued suffering and inanition.

Gouty Spasmodic Colic.—In the "gouty diathesis," this is one mode in which the disease may invade internal organs. The stomach is the most frequent and dangerous seat of it; the attack being commonly called "cramp in the stomach." It is characterized by suddenness, extreme severity of pain, and tendency to coldness and general prostration of the system. Repulsion of gout from the foot, as by cold applications, may bring it on.

Lead Colic; Painter's Colic; Colica Pictonum.—This disease has long been known as the result of exposure to the poisonous influence of lead. The name of "dry belly-ache" has also been applied to it. The abdomen is *shrunken* and rather hard; sometimes *knots* of contracted intestine may be felt. There is no tenderness, the pain being lessened or relieved by pressure. The suffering is often extreme, with restlessness; the face and the body being thrown into grotesque contortions. Constipation is obstinate; the feces, when passed, small, dry, and hard. No fever exists. There is a blue line along the edge of the gums. Lead palsy may attend or follow the colic.

Treatment.—In all forms of colic, the indications in common are, 1, to open the bowels; 2, to relieve pain and spasm; 3, to prevent inflammation; 4, to prevent future attacks.

In *flatulent* colic, we should ascertain if the stomach has just been overloaded, or any very unwholesome food has been taken. If so, a prompt emetic will be proper; as, a teaspoonful of mustard, or a tablespoonful of salt, in a teacupful of warm water—repeated in ten minutes if necessary. Then the antacid laxative,

magnesia, may be given; a teaspoonful with ten to twenty drops of essence of ginger, or ten drops of essence of peppermint, five or six drops of oil of cajuput, or some other aromatic in corresponding proportion. If the bowels are not opened, or relief of pain not obtained, no great length of time must elapse without an enema, of castor oil, salt, and molasses, or soap, in warm water.

Should the stomach be much unsettled, and the pain violent, we may depend upon the immediate use of an injection to open the bowels; and give by the mouth antacids and carminatives. Thus aromatic spirit of ammonia, spirits of camphor, compound spirit of lavender, or oil of cajuput may be given, with bicarbonate of sodium. Small doses every few minutes will be better retained than large ones at long intervals, and will act better.

Anodynes come next in order. Extreme and sudden cases of colic, belonging rather to the *spasmodic* variety, require them *at once*. Other cases, the majority, are better managed by commencing with more *corrective* remedies, as above mentioned. When relief is not obtained without, we must give opium, chloroform, ether, or Hoffmann's anodyne. The first is of all the most certain, although chloroform, internally used, in $\frac{1}{4}$ drachm to $\frac{1}{2}$ drachm doses, has not disappointed. Paregoric is a very good opiate for the same purpose. Pills of opium (especially *old* pills) may do better sometimes, where as much as a grain at once may be needed for severe pain. Laudanum is the oldest stand-by, and well deserves its place.

It is remarkable how much opium a sufferer with great pain will sometimes bear without narcotism. But care must be taken not to overdo this, or to give any more than is really necessary; or, the remedy may possibly prove worse than the disease.

An important part of the treatment of colic is the use of warm external applications. Mustard should come first; a large sinapism, half and half with flour (if the mustard be of good strength) and covered with gauze or thin muslin, over the abdomen. When it is removed after making a decided impression, let a little lard, sweet oil, or cold cream be rubbed on to prevent further irritation of the skin. Then, apply a hot flannel, dry, or wrung out of hot whisky and water. For the latter, the best mode is to add to very hot water an equal quantity of raw whisky. Such appliances should be often *renewed*, or they grow cold. Some persons have a tin vessel constructed to hold hot water, and shaped so as to fit over the abdomen. This is very good, if it can be used without its weight causing too much pressure. The feet of the patient should be kept warm; if he be able to sit up, or to recline with the legs over the side of the bed, a hot mustard foot-bath will be suitable.

Kneading the abdomen gently with the hand will aid to dispel flatus; but it requires tact not to make it too violent an operation. In every case of violent colic, the possibility of *hernia* must be held in mind; and its presence or absence should be ascertained.

Infants are especially liable to crapulent colic; some, during their first year, having almost daily or nightly attacks. Very simple treatment will often suffice in these; in children, too, overmedication should be even more sedulously avoided than in adults. For infantile colic of slight severity, peppermint water, or infusion

of fennel seed, will frequently be enough, with the application of a warm flannel over the stomach. Worse cases may be treated with lac assafœtidæ; which children generally take well, if it be sweetened, in teaspoonful or, for very young infants, half teaspoonful doses. Antacids, as bicarbonate of sodium, will assist in giving relief. Keeping the bowels regular, never allowing a day to pass without an evacuation, is most important in young children.

Bilious colic may be attended by an inflammatory condition. Opening the bowels is a cardinal indication in this as in the flatulent form. If the stomach will bear it, castor oil will be the most effectual cathartic. The least unpleasant way of taking this is, in thorough admixture with spiced syrup of rhubarb; two tablespoonfuls of the latter with one of oil. Magnesia may be retained better than oil upon the stomach. The same *antacid*, *carminative*, and *anodyne* remedies mentioned for crapulent colic, will be suitable in bilious, and may require more persevering administration. So, also, enemata, mustard plasters, pediluvia, and warm applications to the abdomen are of great service. Besides these, however, a special indication exists for promoting the hepatic secretion, so that by greater fluidity and dilution it may be made less irritating and obstructive. A very common treatment, then, is, besides such palliatives as have been named, to give calomel, with opium: *e. g.*, $\frac{1}{2}$ to 1 grain of calomel with about as much opium, every two, three, or four hours. Cups, or, later, a blister, over the liver, may be right, if hepatic or cystic inflammation threaten.

When there is strong reason to apprehend that the passage of a gallstone is the cause of the severe pain, the warm bath, if practicable, will be useful by promoting relaxation; and full doses of opium may be called for by the patient's agony. Some prefer to inhale ether or nitrous oxide.

Fig. 290.

CALCULI IN THE GALL-BLADDER.

Gouty, or other *cramp* of the *stomach*, is generally in need of very prompt treatment; essentially stimulant and anti-spasmodic or anodyne. In moderate cases Warner's cordial (tinct. rhei et sennæ) has the advantage of being laxative as well as stimulating; from a teaspoonful to a tablespoonful may be given at once, in *hot* water. In worse attacks brandy, ether, laudanum, and Hoffmann's anodyne are more reliable, with a sinapism over the epigastrium, and a hot mustard foot-bath. Subsequent treatment, prophylactic of future attacks, as with colchicum or other medication, must be pointed out by the nature of each case.

Lead colic, when rapidly produced, may be treated antidotively, with sulphate of magnesium. If slowly brought on, we can do much less in that way; although it has been asserted that the iodide of potassium has an eliminative power over lead combined with the tissues of the body. Alum is confided in by

some, for the same end, notwithstanding its astringency. Castor oil as a laxative; the warm bath to relax spasm, and opium to relieve spasm and pain, are the most important usual remedies in this affection. The costiveness being mainly spasmodic, it is not unfrequently found that, contrary to its common effect, opium promotes, in lead colic, the movement of the bowels.

Prevention of Crapulent and Bilious Colic.—This becomes the duty, if not the interest, of the physician; when his patient has been relieved, to aid him in escaping returns of the disorder. To prevent the flatulent form, care in diet and regimen will ordinarily suffice. For the more serious attacks of bilious colic, to which certain persons are subject, prevention is attainable by the same means, along with especial attention to the *abdominal movements and secretions; i. e.*, the state of the liver and bowels.

Obstruction of the Bowels.

Few maladies present so striking a contrast as this, between the facility of pathological explanation after death and the obscurity of diagnosis and uncertainty of treatment during life.

Pathological Varieties.—Dr. Haven has well classified these as follows: I. Intermural: *a*, cancerous stricture; *b*, non-cancerous stricture, viz., 1, contraction of cicatrices from ulceration, 2, contraction of wall of the intestine from inflammation; *c*, intussusception; *d*, the latter with polypi. II. Extramural: *a*, bands of adhesions from lymph; *b*, twists or displacements; *c*, diverticula; *d*, tumors or abscesses; *e*, mesocolic or mesenteric hernia; *f*, diaphragmatic; *g*, omental; and *h*, obturator hernia. III. Intramural: impacted feces, calculi, coagula, curdled milk, etc.

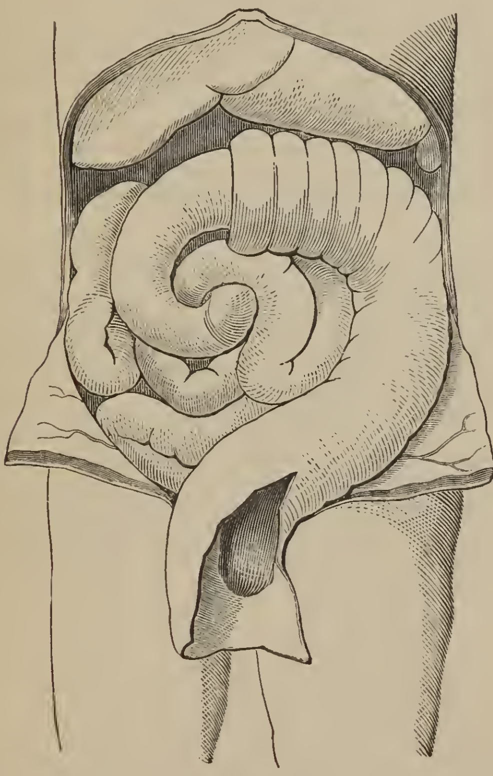
Symptoms of Intestinal Obstruction.—These are, persistent constipation; constant vomiting, partly or altogether stercoraceous; coldness of the skin, prostration, distressed countenance (facies Hippocratica), collapse. Local evidences, rather more distinctive, are hardness or swelling in one part of the bowels; arrest of enemata at a certain point, and of borborygmi (gaseous movements) in the same way. If the obstruction be high up, suppression of the urine occurs, with early vomiting. If it be low down, great meteoric distension and stercoraceous vomiting. When blood is passed from the bowels, with such symptoms, intussusception may be inferred.

But, at last, a *probable* diagnosis is all that the nature of the case will admit. The differential discernment of special forms of obstruction during life is nearly impossible.

Treatment.—The simple, primary indication in persistent constipation with unrecognized cause, is *catharsis*. Castor oil, sulphate of magnesium, croton oil, are, justifiably, given, aided or seconded by enemata of the same or similar purgatives. When the diagnosis of *intestinal obstruction* has been well made out, no more cathartic medicines are to be given; the reliance then being upon nature and opium. This drug may be prescribed in grain or half-grain doses every few hours, to sustain a tranquillizing effect favorable to relaxation of the intestinal coats. Besides, we may try *large* enemata of warm water; or inserting a bougie, or stomach-tube, to *catheterize* the bowel, as far as the ileo-cæcal

valve; or, the Hippocratic remedy of large *air* injection, to distend and dislodge the intestine. This has succeeded in several cases

Fig. 291.



INTUSSUSCEPTION OF CÆCUM AND ASCENDING COLON INTO THE DESCENDING COLON AND SIGMOID FLEXURE.

of intussusception. *Scybala*, or impacted feces, or coagula, etc., may be removed by a spoon or scoop from the rectum. Prolonged use of the warm bath may be tried to relax the system; and, as in strangulated hernia, the tobacco injection may be allowable as an extreme resort. *Colotomy* is now sometimes practised.

Cholera Morbus.

This name has become attached to what in technical phrase may be most briefly called *idiopathic emeto-catharsis; i. e.*, vomiting and purging, neither brought on by irritant poisons, nor by an epidemic

influence. English medical writers describe it sometimes as English cholera; others sporadic cholera.

SYMPTOMS.—Nausea, and vomiting of greenish or yellowish fluid, with rejection of all food and drink; often, but not always, pain in the stomach and bowels; diarrhœa, with brownish or yellowish stools; debility, and coldness; little or no fever. Beginning with such symptoms, if the attack, not relieved, becomes aggravated, cramps in the limbs supervene; the vomiting and purging become more watery; prostration and coldness deepen into collapse—which may be fatal.

CAUSATION.—Warm weather seems to predispose to it, by relaxing the mucous membranes and exciting the liver. Direct causes often are, indigestible articles of food, as unripe fruit, etc.; excess of ordinary food; sudden change of temperature, checking perspiration.

DIAGNOSIS.—From epidemic cholera, it is important to distinguish cholera morbus; as the prognosis is not the same, nor will the same treatment answer for both. The difference is seen in the *bilious* vomiting and purging of cholera morbus, and *rice-water* discharges of cholera; the greater nausea in the former; much more tendency to collapse, with blueness, dyspnœa, and suppression of urine, in cholera. The presence or absence at the time of an epidemic of the latter may complete the diagnosis by confirming or correcting the evidence of the above signs. It is only in an extreme case of cholera morbus that any real difficulty should exist. During, and before and after, the prevalence of epidemic cholera, an especial tendency to cholera morbus, as well as to diarrhœa, often exists. This, called *cholerine*, may present more near resemblance to malignant cholera than our ordinary summer attacks.

TREATMENT.—A large sinapism should be at once placed over the epigastrium. The following mixture is useful in ordinary summer cholera morbus:—

> ℞.—Sp. ammon. aromat. f℥j.
> Magnes. optim. ℥j.
> Aquæ menthæ piperitæ f℥iv.—M.
> To be shaken when taken.
> S.—A teaspoonful every twenty minutes.

Few cases will fail to be relieved in an hour or two if this be given *early*. The use of calomel and opium pills is a more common practice.

When the diarrhœa is copious, or the case is seen rather late, paregoric may be added to the above;—f℥ij or f℥ss in the same mixture. When purging is very urgent and exhaustive, instead of magnesia a like amount of bicarbonate of sodium may be used. Infusion of cloves, cinnamon, or ginger may assist to quiet the stomach in an obstinate case. After the sinapism, a spice poultice, of ginger, cloves, and cinnamon, each a full teaspoonful, with a tablespoonful of flour, moistened with brandy, should be applied. Ice may be given if thirst be great.

Extreme prostration may require the use of brandy internally. To check the diarrhœa and vomiting when threatening collapse, a laudanum and starch enema (40 to 60 drops of laudanum in ½

ounce of starch) may be given; and a blister may be applied over the stomach; the part to be dressed, when vesicated, with 2 grains of acetate of morphia mixed with 10 of powdered gum arabic.

Diarrhœa.

Though rather a symptom than a disease, excessive discharge from the bowels often requires express treatment for its relief.

VARIETIES.—These are principally, 1. Irritative diarrhœa, as from dentition; 2. Inflammatory, as in enteritis; 3. Symptomatic, as in typhoid fever; 4. Critical, as at the close of remittent fever; Eliminative, as in septic or other poisoning; Colliquative, as in phthisis.

The character of the *discharges* varies very much. They may be, 1. Fecal, although liquid; 2 Bilious; 3. Mucous; 4. Serous; 5. Adipose (very rare).

Except in the beginning of attacks, discharges are rarely fecal in character when much beyond the normal amount. The *gutter-water* discharges of typhoid fever often have nearly the fecal appearance except in consistence. *Mucous* discharges occur in enteritis, and in many cases of summer diarrhœa. *Bilious* passages occur in cholera morbus. *Serous*, or "rice-water" in malignant cholera.

TREATMENT.—An important point is, that in many cases diarrhœa ought not to be abruptly checked; in some it should not be interfered with at all. The latter is true of the looseness of the bowels in typhoid fever, if the passages are not more than three daily, and are but moderate in amount. When excessive in that disease, they require checking, not arresting.

Ordinary summer diarrhœa, the most nearly "idiopathic" of all forms, demands *correctives*, generally, before or with astringents. Hydrargyrum cum cretâ; magnesia, with charcoal or with aromatic syrup of rhubarb; bicarbonate of sodium, with ginger or cinnamon, etc., will often relieve the condition of the alimentary canal in which diarrhœa originates, and thus end it without any astringents.

When the latter are indicated by continuance or increase of the discharges, *chalk mixture* has long held a routine place as an early prescription. Instead of it, some prefer *testa præparata*, or *oculi cancrorum*. In infants, lime-water, with cinnamon or camphor water, will do for mild cases. Kino, catechu, krameria, and hæmatoxylon are familiar as pure astringents. The addition of opium, or camphor, or both (as in paregoric) in small doses to such preparations is generally proper, to increase the binding effect, even in the absence of pain.

More obstinate cases should be treated with tannin (gr. iij in pill, with $\frac{1}{4}$ or $\frac{1}{2}$ grain of opium, pro re nata), or pills of acetate of lead and opium (gr. j of the acetate, with gr. $\frac{1}{2}$ of opium) every three or four hours; or a mixture containing acetate of lead with acetate of morphia; aided when necessary by enemata of laudanum and starch (30 to 60 drops of laudanum to $\frac{1}{2}$ ounce of starch, cool or cold). As an article of diet in feeble cases, arrowroot with brandy will be especially suitable.

In *chronic* diarrhœa, besides the remedies last mentioned, sometimes enemata of acetate of lead solution, or of some other

mineral astringent, will do good. Mention of these will be again made in connection with *chronic dysentery*.

The *food*, in cases of diarrhœa, always requires regulation. Vegetables and fruits, as a rule, ought to be forbidden; the popular prejudice which makes the blackberry an exception is a mistake. It has had its origin in the known astringency of the *root*. Boiled rice, and other *farinacea*, will nearly always be suitable. In severe cases, all solid articles of food should be withheld.

Cholera Infantum.

Popularly known as "*summer complaint*," this affection is very destructive to young children in the large cities of this country, in hot weather. The peculiar influence of high heat in an atmosphere contaminated by "town" causes, generates it. In New York and Philadelphia, its prevalence and mortality coincide with the rise of the thermometer above 90°.

SYMPTOMS.—These are, diarrhœa, vomiting, rejection of food, languor, debility, apathy; sometimes stupor. At first the head may be hot, the abdomen swollen; as the case progresses, coldness and emaciation supervene. In some, with predominance of cerebral symptoms, death may be threatened after a very few days of sickness. In others, copious diarrhœa and constant vomiting endanger the same result. In many cases, however, without violent symptoms, the child is gradually reduced by diarrhœa and inanition. The period of dentition is particularly liable to this disorder; it seldom occurs after four years of age.

TREATMENT.—*Correctives* are, here, especially important in the beginning. Many physicians of experience believe in the great value of moderate doses of *calomel* in the early stages of summer complaint. When stomach or head symptoms predominate, with but little diarrhœa, calomel with magnesia will do the best. When there is more looseness, bicarbonate of sodium should be used, with the calomel, instead. Spiced syrup of rhubarb may be added to either. Hydrargyrum cum cretâ is the preferred mercurial with many practitioners.

A spice poultice or plaster should be kept over the abdomen so long as vomiting continues; being renewed or wet freshly with brandy often enough to maintain its strength. Ice (pounded in a rag for young infants) may be given more often than water to quench thirst. The food may be lime-water and milk, arrowroot, farina, chicken-water, beef-tea. After the first stage, many children will require small quantities of brandy or whisky (preferably with their food) for support.

In the early stage, if the head be hot, and stupor be threatened, the application of cold water, upon a light cambric handkerchief, to the head, may be proper and important. Such a stage, however, does not often last long.

Later, the two difficulties are, to check the diarrhœa, and to overcome the rejection of food by the stomach. For the bowels, astringents are than called for; especially logwood, blackberry root, geranium, krameria; aided in serious cases by paregoric in small quantities by the mouth, or even the injection into the bowels of one, two, or three drops of laudanum with starch.

Sometimes acetate of lead injections (from one to three grains, with starch) may be farther needed, for the same intent.

Protracted summer complaint affords scope for perseverance and contrivance in finding food available for the child. Well-made beef-tea agrees with most children. *Raw beef, scraped* or rasped fine, has been found to answer the purpose best with some.

But all medical treatment may fail in some cases of cholera infantum, which will speedily recover on being removed from the city to the country. The immediate effect of a salubrious air is often suprising and delightful.

Prophylaxis.—This is very clear and simple. A child under five years of age ought never to be kept in the closely built parts of a large city, in our climate at all events, through June, July, and August, if it can be helped. Next to a *residence* for the summer, in a high and open country, will be the benefit of frequent *excursions* or visits; riding or sailing; or even, if nothing else be possible, being carried daily into the squares or parks of the city.

Dysentery.

Definition.—An inflammation of the large intestine, involving the muscular as well as the mucous coat.

Varieties.—Acute and chronic; sthenic and asthenic; endemic or epidemic; bilious; ulcerative; strumous or tuberculous.

Symptoms.—Pain in the lower half of the abdomen, with soreness or tenderness on pressure or motion; frequent disposition to go to stool, with small and bloody or blood-marked muco-fecal or mucous passages, sometimes containing shreds of lymph or false membrane; tendency to strain (tenesmus) with griping (tormina); fever in most acute cases.

Severe and protracted cases may be considered as going through, 1st, the inflammatory, and 2d, the ulcerative stages.

Simple *acute* dysentery is commonly sthenic, or open, active, and inflammatory, without early or great tendency to prostration. Endemic or epidemic dysentery (the first name is the more correct) is generally asthenic. In this form fever may be absent, or brief, or of a typhoid character. Vomiting is not rare in this, as it is in the ordinary acute form. Coldness and debility come early.

Sometimes, in malarial districts, dysentery, like all other maladies, may be intermittent; with daily or tertian exacerbations and intervals.

Morbid Anatomy.—Redness, turgescence, thickening, softening, ulceration, suppuration, and occasionally pseudomembranous deposits, are, after death from dysentery, found, in various degrees, in the rectum, colon, and cæcum; chiefly in the lower bowel. The hemorrhage which makes the typical bloody stools, is due to the congested and inflamed mucous membrane being constricted, in the tenesmus, by spasmodic and irregular contractions of the muscular coat.

Chronic dysentery presents nearly always ulceration of the rectum or colon, or both. The discharges in this may become almost entirely muco-purulent.

Causation.—Predisposition to dysentery is common in the latter part of summer; in this city and neighborhood, from the

middle of August to the end of September especially. Relaxation from heat, with sudden exposure to cold and wet, may produce an attack. So, often, will indigestible food; as unripe fruit. Bad drinking water is another cause.

At any season and locality such agencies may produce simple acute dysentery. But in certain regions it becomes at times endemic. This is particularly noticed in many localities having considerable elevation, not subject to malarial fevers, but *within a short distance* of ague districts; dysentery upon the hills, while intermittent and remittent occur in the adjoining or subjacent valleys and meadow lands.

PROGNOSIS.—Either form of dysentery *may* be fatal; but the endemic and asthenic type is much the more dangerous. The other, with good *early* treatment, is generally quite manageable. When allowed to become chronic and ulcerative, the doubtfulness of recovery is much greater. *Bilious* dysentery, that is, the form in which disorder of the liver is a prominent feature, the discharges presenting an excess of more or less altered, irritating bile, is more intractable than ordinary simple dysentery.

TREATMENT.—*Simple acute form.* At the very *start*, the old practice of beginning with a dose of castor oil, with ten or fifteen drops of laudanum, will do very well. If left for a day or two, it had, as a rule, better be omitted. Early leeching is often useful.

Then the first prescription, in a mild or moderate case, may be of blue mass with ipecacuanha (gr. $\frac{1}{4}$ to $\frac{1}{2}$). After one or two days (sooner in an urgent case), camphor may be added, in pill. Next, we may substitute for the blue pill, opium; afterwards, omit the ipecac., continuing the opium and camphor, *pro re nata.* If the disorder be not checked, we must resort to acetate of lead, with opium, or in solution with acetate of morphia.

Perfect rest is indispensable to prompt recovery from dysentery; there is no disease in which this can be more important.

The diet must be bland; as rice-water, arrowroot, or other farinacea; chicken-water, or beef-tea in the feeblest cases. When thirst is intense, iced rice-water or benne-leaf tea, or infusion of slippery-elm bark may be used as a drink; or, during the active stage, ice in substance may be taken slowly.

Enemata are very important in dysentery. First, of flaxseed-tea, as a demulcent (two to four fluidounces at once); the same with laudanum; or laudanum with starch. In chronic cases, or obstinate acute ones, acetate of lead may be given by enema, with laudanum, in mucilage. So may sulphate of zinc, and nitrate of silver. Solution of tannic acid, in water or in glycerin, will be worthy of trial for a similar purpose.

Asthenic, endemic form.—In this there will be need of the earlier use of opium; and, often, of quinine, and stimulants. No leeching, or little, is likely to be well borne; and ipecac. may be prohibited by vomiting. When it can be taken, in small doses (not more than $\frac{1}{2}$ a grain), I believe it to be a valuable remedy. When malarial influence is obvious, and most of all in the intermittent form, quinia or cinchonia will be the remedy, to which others are adjuvants. *Hope's mixture* will be more likely to do good in this, the adynamic, than in the simple acute form. (℞.—Acid. nitric.

f℥j; tinct. opii, gtt. xl; aquæ camphoræ, f℥viij. Dose, a tablespoonful.)

Bilious Dysentery.—As a distinctive variety, this is not uncommon; and, if it last over ten days, it may be very hard to cure. Ordinary anti-dysenteric medication will not be inappropriate to it —but may disappoint much more than it is apt to do in simple acute cases.

CHAPTER IV.

AFFECTIONS OF THE LIVER.

Acute Congestion.

THIS, with deficient secretion of bile, is very common, as the result of exposure to cold and wet in warm seasons or climates, of the chill of intermittent, or of excesses in diet. Its symptoms are, a sense of weight and slight or moderate pain in the right hypochondriac region and under the right shoulder-blade, constipation with lead-colored stools, nausea, a furred tongue, bitter taste in the mouth, a yellowish skin and conjunctiva, and headache or dizziness.

TREATMENT.—Two or three grains of blue mass at bedtime, one, two, or three nights (two grains only if repeated). When decided constipation exists, one purging dose in the morning of sulphate or citrate of magnesium, or of magnesia. Then ten or fifteen grains of bicarbonate of sodium twice daily, with light diet.

Chronic Congestion of the Liver.

A number of attacks of temporary hepatic congestion, or of hepatitis, or prolonged dyspepsia, or intermittent or remittent fever, may induce a chronic hyperæmia of the liver, with variable disturbance of function. Pain in the right side and shoulder, with sallowness of complexion, constipation and lowness of spirits, are the principal symptoms.

TREATMENT.—Supposing blue mass to have been temporarily and sufficiently used, as the leading cholagogue (so established by ample *clinical* proof, notwithstanding the failure of a *portion* of the physiological experimentation upon the subject), nitromuriatic acid may be then given, 3 or 4 drops twice or thrice daily, for two or three weeks successively. Or it may be used in a bath (f℥vj–viij in each gallon of water). Taraxacum, 10 or 20 grains of the extract twice daily; or a wineglassful, as often, of the decoction of the root; or the fresh leaves in spring or summer, eaten as greens, may follow. Leptandrin (dose, gr. j–iij) is said to be mildly cholagogue and safe. Ordinary laxatives, as rhubarb, etc., may be used to regulate the bowels. Care of the skin, by bathing, proper clothing, and if chilly, friction with hair gloves or a rough towel (salt bathing will be very good) is important. Exercise in the open air, not violent, should be had every day. Change of air, mineral waters, or sea bathing may be advised.

Hepatitis.

The most common form of inflammation affecting the liver is what some writers call "gastro-hepatic catarrh;" considered under Gastritis. There is reason to believe the duodenum, stomach, gall-duct, and liver to be all in variable degree involved in such attacks.

Hepatitis may also be *traumatic*. Whether so or idiopathic, either the parenchymatous tissue, Glisson's capsule, the biliary ducts, or the portal vein, or all together, may be the seat of inflammation.

Some of the symptoms are nearly the same in all cases, and are in part the same as in acute congestion of the liver; but the pain in the side is greater, with some tenderness on pressure; there is fever, often vomiting, and sometimes diarrhœa.

In inflammation of the capsule (perihepatitis) the tenderness on pressure, movement, or deep inspiration, is considerable; the fever, slight or absent; and there is no jaundice. This may sometimes be confounded with *diaphragmatic pleurisy;* but there is, in the latter complaint, more severe pain, with cough, dyspnœa, and hiccough.

Inflammation of the portal vein may proceed to suppuration. Then the symptoms are scarcely distinguishable from those of hepatitis with abscess, to which attention will be given presently.

When inflammation is chiefly confined to the gall-bladder and ducts, the points of diagnosis are, the comparative absence of fever, and the considerable degree of jaundice.

Abscess of the Liver.—Although much most common in tropical climates, this may be met with anywhere. Besides the usual symptoms of hepatitis, when pus is forming, we find rigors, recurring almost as regularly as in intermittent, a very rapid pulse, prostration, copious perspirations, and loss of flesh. In a considerable number of cases, however (13 per cent. according to Louis), the disorder is latent; being made known only by the consequences of suppuration.

The greatest danger attends the escape of pus from the abscess. This occurs spontaneously either through the diaphragm by the lungs, into the stomach, or intestinal canal, into the peritoneal cavity, or, in a minority of cases, through the skin. Any of these may be followed by recovery, except the escape into the cavity of the peritoneum. In this instance, death is almost certain.

The *causes* of abscess of the liver, besides the predisposition belonging to hot climates, are, 1. Blows or wounds; 2. Inflammation of the portal vein, with transfer and deposit of pus; or *thrombosis* from some other vein, as the hæmorrhoidal; 3. Dysenteric ulceration; 4. Inflammation and suppuration of the gall-bladder or gall-ducts.

Treatment of Acute Hepatitis.—All mercurials should be avoided. Saline cathartics are proper, with rest in bed, low diet, and cooling drinks. A blister may follow leeches or cupping.

The most serious question occurs when suppuration is known or believed to have taken place. Can we prevent or lessen the dangers of the discharge of the *abscess?* Nature in many cases makes

this secure, by adhesion of the liver to the stomach or bowel, so as to allow the direct flow of the pus into the canal. In other instances, deep-seated fluctuation may be felt below the edge of the ribs. Possibly this might be from a *dilated gall-bladder*, or *hydatids* of the liver. But, if sure that it is an abscess, ought we to open it? The most prudent answer is, not unless we are confident that only the skin intervenes between the pus and the exterior. Dieulafoy's *pneumatic aspiration*, through a capillary tube, is here especially applicable, both for diagnosis and treatment.

After the discharge of the abscess, convalescence may be expected; it is sometimes rapid, but may require a month or more.

Jaundice.

Icterus or jaundice is a morbid yellowness of the skin, eyes, and other parts. It has no uniform pathology, causation, or concurrent symptoms; but is itself so marked an occurrence as to deserve special study. Sometimes it is even epidemic; as in the U. S. Army in malarial districts during the late war; to the extent of over 10,000 cases in a single year.

Varieties.—As to degree—*yellow*, *green*, and *black* jaundice. As to causation, jaundice from *suppression*, and from *re-absorption* of bile; and *icterus neonatorum*, jaundice of young infants, of still different origin.

Symptoms.—In the ordinary acute cases of jaundice, either suddenly or after some days of *malaise*, the whites of the eyes first become tinged with yellow; next, the roots of the nails, the face, neck, trunk, and limbs. The urine is of a porter color, stains linen yellow, and becomes green on the addition of nitric acid. At the same time the stools are slate or lead-colored, or almost white. The mouth has a bitter taste, and the patient suffers with lowness of spirits and indisposition for exertion.

Pathology and Causation.—Many affections of the liver may induce jaundice; although in some of the most serious of them it may be absent. Most distinctly it is traceable in different cases to the non-removal of the biliary coloring matter, as well as of cholesterin, from the blood by the liver; other organs, especially the skin, then receiving it; or, to obstruction preventing its transit, after secretion, through the intestinal canal, in which case it is reabsorbed into the blood and then thrown out elsewhere.

The remote causes of jaundice of greatest frequency are, malaria, exposure to cold and damp in hot weather, pregnancy, and violent mental emotion.

Diagnosis.—In either form of jaundice we have the yellow conjunctiva and skin, or serum, if a blister be applied, or blood drawn; in both forms the stools are without color, and the urine yellow or yellowish-brown. But, as Harley first pointed out, in jaundice from *suppression* the biliary *acids* have not been formed, and we find only the bile *pigment* in the urine; while in jaundice from *re-absorption*, that fluid contains *both*.

After a time, in cases in which the secretory powers of the liver become impaired, the biliary acids disappear; and then, *tyrosin* and *leucin* are found in the urine.

Prognosis.—Acute jaundice is not very fatal. In the U. S.

Army, of 10,929 cases, only 40 died. When it lasts a month or two, however, as well as when acute yellow atrophy of the liver exists, there is always danger connected with its organic cause. The jaundice of young infants is of short duration, and is almost never of serious consequence.

TREATMENT.—When supposed to be temporary and functional, the great object must be to restore the action of the liver. As remarked already, the large accumulation of clinical experience, sustained by some though not by all of the physiological experiments made by vivisectors, compels us to believe that calomel and blue mass and other mercurials are *cholagogues*. If they be not so *always* in trials upon animals in *health*, they have proved so *generally* in human beings in case of torpor of the liver. If *obstruction* be the trouble, their action is more doubtful, necessarily. But even then they may promote the solution of a recent gall-stone, if they render the bile more copious and liquid.

Small doses of calomel or blue pill may be urged, then, generally during the first week or more of treatment. These may be aided by saline purgatives, as sulphate or citrate of magnesium, Rochelle salts, or cream of tartar. After them, small doses of *resina podophylli* may be tried, if required by persistence of the disease; or, if the bowels will not bear purging, extract of taraxacum. Bicarbonate of sodium, taken before meals, is mildly cholagogue. But, in a case of some weeks' duration, slow to recover, nitromuriatic acid, 3 or 4 drops twice or thrice daily, will often hasten recovery very much.

Acute Yellow Atrophy.

This is a generally fatal affection, occurring most frequently in those who have been intemperate, or injured by venereal excesses, or who have been exposed to malaria.

SYMPTOMS.—Beginning like ordinary jaundice, with nausea, constipation, and headache, the skin becomes intensely yellow ("black jaundice"); vomiting comes on, the pulse is rapid, though variable, and delirium occurs. Then, with fever and often pain in the side, the stomach and head are more and more disturbed. Vomiting of altered blood takes place; not unfrequently also hemorrhage from the bowels. Petechiæ appear on the skin. Prostration, tremors or convulsions, and *coma* end the history, usually in less than a week.

SECRETIONS.—Marked *deficiency* of *urea* in the urine, and the presence of *leucin* and *tyrosin* in that excretion, have been observed.

MORBID ANATOMY AND PATHOLOGY.—The liver, after death, is *flattened out* and lessened to half its normal size. Its cut surface has a yellow color like rhubarb; the bloodvessels are empty. The lobules are not distinctly marked; many of the secreting cells being destroyed; in their place are masses of spots of dark bile-pigment, fat, and hæmatin. The kidneys are often found in a state of partial degeneration. The appearances somewhat resemble those found after phosphorous poisoning.

Evidently atrophy, with cessation of functional action of the liver, is here the cardinal fact. Is it preceded by a violently destructive inflammatory process? Some of the symptoms would

point to this. Yet, in the absence of autopsic evidence, uncommon as primary rapid atrophy seems to be in any organ, the precedence of inflammation must not be taken for granted. The immediate cause of death seems to be cholæmic poisoning.

Diagnosis.—From acute hepatitis this complaint is distinguished by the greater amount of jaundice, the occurrence of hemorrhage from the stomach or bowels, the severe headache and stupor; but, most of all, by the *diminution of dulness on percussion* over the hepatic region, in connection with symptoms showing violent disorder of the liver. The urine will also be found after evaporation to contain *tyrosin* and *leucin;* sometimes in crystalline deposits.

Treatment.—Unless in the earliest stage we are warranted in endeavoring to promote the normal "unloading of the portal circle" by purgatives, it is difficult to see any hopeful indication for treatment in this affection, other than palliation of fever, if there be such, by diaphoretics, aiding the depuration of the blood by diuretics and laxatives, and prolonging life by appropriate *support.* It is doubtful whether any cases recover from acute yellow atrophy of the liver.

Pigment Liver.

Frerichs, J. F. Meigs, and others have found, after death from remittent fever, or in patients dying from other diseases after exposure to malarial influence, a peculiar condition of the liver. It is steel-gray, or blackish, or chocolate-colored; presenting brown insulated figures upon a dark ground. This change of color is due to the accumulation of pigmentary deposit in the bloodvessels.

The spleen also is somewhat similarly altered; and so, to a less extent, are the brain and kidneys. The blood is deficient in corpuscles, and contains many floating particles or masses of pigment.

Diagnosis.—During life, examination of a few drops of blood will display the abundance of free pigment. The skin is sallow or dull yellow. Enlargement of the spleen, anasarca, albuminuria, diarrhœa or intestinal hemorrhage, and delirium or a tendency to stupor, may occur. There is but little jaundice.

Cirrhosis.

Synonyms.—*Hob-nailed liver, gin-liver.*

Anatomy and Pathology.—In its commencement or first stage, cirrhosis is attended by some increase in the bulk of the liver; with increase also of its firmness. When the disease is more advanced, the organ lessens in size, especially the left lobe; the induration becomes aggravated. Knobs or granulations (nutmeg liver) project all over its surface. The capsule of the liver is always thickened.

The character of these alterations is believed to be due to the new formation of connective tissue in the ramifications, through the gland, of Glisson's capsule. Bands of this material constrict the lobules, obstructing the bloodvessels and bile-ducts, as well as the gland-cells. Thus diverse effects are produced.

Inflammation of the capsule of Glisson, and its interstitial rami-

fications, is considered by most pathologists to be the primary element of cirrhosis.

SYMPTOMS.—Nausea and indigestion, with a furred tongue and slight yellowness of the skin and eyes, are the earliest (of course not pathognomonic) manifestations of this disease. Afterwards, mostly with slow progress, come constipation, vomiting, emaciation, debility, ascites, with or without general dropsy, and enlargement of the superficial abdominal veins. This last sign is especially significant of obstruction of the hepatic circulation. Towards the close of life, hemorrhage from the stomach or bowels, delirium, coma, or convulsions are apt to occur.

DIAGNOSIS.—From acute congestive or inflammatory affections of the liver, the slow progress of cirrhosis readily separates it. From fatty and waxy liver, and from cancer, it is distinguishable, though not always with ease, by the continued enlargement of the organ in those affections; while they are also less constantly attended by dropsy and enlargement of the abdominal veins. Chronic peritonitis is sometimes difficult to diagnosticate from cirrhosis; but in the former there is more abdominal tenderness, and less enlargement of the superficial veins.

PROGNOSIS.—Recovery from cirrhosis of the liver is not to be expected; but its duration varies greatly, and may be favorably modified by regimen and treatment.

CAUSATION.—Although malarial influence and syphilis may predispose to it, the special cause of cirrhosis is believed to be alcoholic poisoning. It is one of the most common results of continued intemperance.

TREATMENT.—Having the hope only of palliation and delay, we must, most of all, prevent the persistent action of the cause, by enforcing abstinence from spirituous liquors. Nourishing diet is, at the same time, very important. Milk, if well digested by the patient, meat, or concentrated liquid animal food, as beef-tea, chicken-broth, etc., will be suitable. The secretion must be attended to. Saline laxatives, especially the bitartrate of potassium, will often be useful. Bitters or other stomachics may be called for to relieve nausea and strengthen digestion. Dropsy may sometimes require tapping.

Fatty Liver.

This form of degeneration is not uncommon in intemperate persons, or in those suffering from prolonged debility, as in phthisis. Perhaps its association with the latter disease is the most frequent.

In its *diagnosis*, beyond the fact of enlargement of the liver, with smooth margin and surface, in an enfeebled constitution unaffected by the symptoms of other hepatic disorders, there is nothing positive. The change may go on undiscovered even by a careful observer, until after death.

Anatomically, the liver-cells are gorged with oil; their nuclei being destroyed or obscured. With enlargement, the whole organ presents a pale and flabby as well as greasy aspect; and the latter property is obvious to the touch.

There is no *treatment* especially appropriate to this affection, other than what the constitutional state will point out for itself.

Waxy Liver.

SYNONYMS.—*Amyloid*, *lardaceous*, *colloid* degeneration of the liver.

This is often an accompaniment of fatty degeneration; but also occurs quite frequently without it.

ANATOMY AND PATHOLOGY.—The waxy liver is pale or mottled in hue, and, when cut, smooth, hard, and dry. It is heavier than natural. The degeneration probably begins in the lobular ramifications of the hepatic artery, and extends to the secreting cells. Under the microscope these are found to have a pearly look, and to have lost their cell-walls and nuclei. The acini or lobules remain very distinctly marked out.

Fatty degeneration may coexist with the waxy; and hence they have been confounded together. The weight of the liver is modified (made lighter) by the presence of fatty degeneration.

The term *amyloid* has been given to the waxy or colloid change because of a starch-like chemical reaction of the degenerated material. It is hardly to be said that the chemical discussion on this point has yet ended.

SYMPTOMS AND PHYSICAL SIGNS.—Anæmia, emaciation, and dropsy (with, often, vomiting or diarrhœa, but little or no jaundice), unexplained by other local or general causes, and occurring in a scrofulous, syphilitic, or malarial diathesis, may cause a suspicion of this form of degeneration.

Examination confirms this if we also find the liver uniformly enlarged and firm, with at the same time enlargement of the spleen, and albuminuria.

DIAGNOSIS.—Fatty liver does not exhibit so much increase in size, and it is of a softer consistence upon pressure; splenic enlargement and albuminuria less often attend it; and the same is true of the dropsy. Syphilitic inflammation of the liver differs from it in presenting prominent nodules upon the surface of the organ.

CAUSATION.—Syphilis is the most common predisposing cause of waxy degeneration. The tubercular constitution probably comes next. It exists most frequently in males.

There is no especially indicated *treatment* for this affection.

Syphilitic Liver.

Among the organic affections now recognized as displaying locally the effect of the syphilitic diathesis, is a form of chronic hepatic inflammatory degeneration; that is, inflammation followed by a specific organic change of structure.

Anatomically, the liver is somewhat enlarged; with an uneven surface, from the cicatrices alternating with nodules. This unevenness may be felt upon palpation through the well of the abdomen. The patient is pale, but not jaundiced; and dropsy is not present as a symptom, unless from other organic causes.

In *diagnosis*, syphilitic liver is to be distinguished from *cancer* of the liver by the smaller size and softer consistence of the projecting nodules in the former, the absence of tenderness on pres-

sure, and, usually, by the signs of general syphilis; as, the marks of cicatrized ulcers in the throat, copper-colored blotches upon the skin or nodes upon the bones.

Cancer of the Liver.

Mostly in middle life, but occasionally even in the young, cancer of the liver occurs, and has a more rapid progress than most cancers. The *symptoms* are, pain in the right side and shoulders, with tenderness in the right hypochondriac region, disorder of the stomach and bowels, rigidity of the abdominal muscles (especially the rectus), debility, emaciation, a cachectic aspect, and ascites or general dropsy. There is usually little or no jaundice.

Physical exploration shows dulness on percussion below and above the usual limits of the liver; and, on palpation, irregular prominences, hard in most cases, but sometimes, in encephaloid cancer, soft and elastic. The enlargement may become very extensive; and then all the effects of pressure, upon the portal vein, etc., are observed.

This disease is always fatal; affording no room for any other than merely palliative treatment. Its duration is often less than six months; seldom more than a year.

Hydatids.

These are elastic tumors, consisting of *cysts*, developed around *echinococci*. The latter are the larvæ or immature progeny of a *tænia;* they are found not only in the liver,[1] but also in the brain, muscles, bones, ovary, uterus, kidneys, lungs, heart, spleen, etc. The sac or cyst grows slowly, and may exist for years without great disturbance of the health. If any symptoms occur, they are indigestion, debility, and dropsy.

Hydatids are discovered upon inspection and palpation; the liver being considerably enlarged, so as to press up the diaphragm and right lung, or to sink far down into the abdomen. On percussion, besides an irregular line of extended dulness, a peculiar jelly-like vibration is sometimes perceptible by the finger used to percuss upon. If the tumors be so near the surface and so evidently elastic as to warrant the operation of exploration with a grooved or hollow needle, the fluid drawn out will be very characteristic. It is colorless, of specific gravity not much above that of water (1007–1010), and is free from albumen; it contains a large amount of chloride of sodium.

Sometimes the entozoa within the cyst die, and the sac collapses and disappears. In other cases it bursts and is discharged into the alimentary canal, the lungs, or externally through the abdominal walls. Slow recovery may then be anticipated. Danger always exists, however, that the hydatids may open into the pleural or peritoneal cavity, producing pleurisy or peritonitis. In a few instances suppurative inflammation occurs in the cyst.

In the TREATMENT of hydatids, some physicians have been disposed to confide in the supposed power of iodide of potassium, and

[1] Of 508 cases of hydatids, Cobbold and Davaine found the liver to be affected in 216.

of chlorate of potassium, taken internally, to cause the absorption of the fluid of the cyst, and thus destroy the parasite. But the evidence is not such as to justify this confidence.

Very large and superficial hydatids may, when the diagnosis is clear, be *tapped*, with at least temporary relief to the patient. Should this be safely done without cure, it may be repeated, and then a gum-elastic tube may be introduced and retained in the opening, so as by drainage to induce the shrinking of the cyst and the destruction of the *echinococcus*. Dr. Pavy reports success in one case with injection of male fern into a hydatid cyst of the liver; its anthelmintic or parasiticide power seeming to be thus shown.

Dilatation of the Gall-Bladder.

This may be produced by obstruction of the gall-duct or the common bile-duct, or, more rarely, by a morbid formation of serous fluid within it, allied to a local dropsy. The diagnosis of this may be important, as it may readily be confounded with hepatic enlargement. It is to be distinguished from cancer by the great amount of jaundice (in most cases), the previous occurrence of gall-stone colic (also not invariable), and the more uniform and softer character of the swelling. From hydatids the same signs, except the softness of the tumor, are distinctive; and the latter grow much more slowly.

For the TREATMENT of dilatation of the gall-bladder, the remedies suitable for obstruction of the biliary ducts will be appropriate. Surgical interference would, in any case, be very bold practice; unless with the pneumatic aspirator of Dieulafoy.

CHAPTER V.

AFFECTIONS OF THE SPLEEN.

THESE are necessarily treated of at length in systematic treatises. It will be enough for our purpose to say a very few words of them. The spleen is commonly *enlarged* in *intermittent*, *remittent*, and *typhoid* fevers, and in *leucocythæmia;* sometimes in pregnancy (Simpson). *Rupture* of the spleen, causing death, has been several times reported. Such an affection could scarcely (*i. e.*, rupture of the spleen) be diagnosticated during life.

Enlargement of the spleen is readily ascertained by inspection and palpation. It often increases and diminishes, during and between the paroxysms of intermittent (ague-cake). Piorry asserts its *rapid* diminution under cinchonization. Other affections of the spleen (*inflammation*, *tubercle*, *hydatids*, etc.) are so generally difficult of diagnosis as to have chiefly a post-mortem interest; and they present no clearly recognized indications for treatment.

CHAPTER VI.

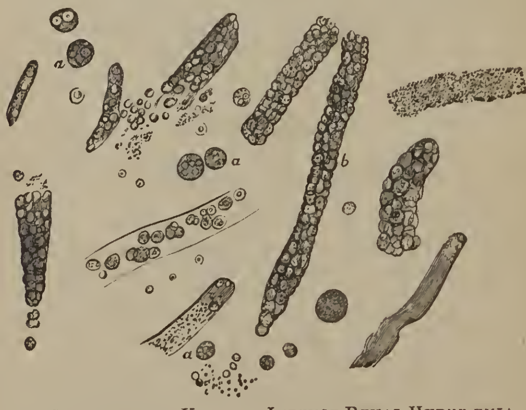
AFFECTIONS OF THE KIDNEYS AND BLADDER.

Congestion.

CAUSATION.—Under exposure to cold, overdoses of cantharides or turpentine, or the disturbance belonging to the different inflammatory and febrile complaints, *active* renal congestion may occur. *Passive* congestion is more common in heart-disease, or pulmonary obstruction, as in pleuritic effusion or emphysema, or when pressure impedes the circulation of the renal veins or vena cava, as in pregnancy or abdominal tumors.

SYMPTOMS.—Pain in the lumbar region, sometimes with tenderness on pressure on each side of the spine. Scanty urination, the fluid being high-colored, sometimes bloody, or containing albumen. Certain cases exhibit under the microscope fibrinous casts.

Fig. 292.



RED DEPOSIT FROM URINE IN INTENSE RENAL HYPERÆMIA.

DIAGNOSIS.—It is only occasionally difficult to distinguish this condition from Bright's disease. Active congestion begins abruptly, under a recognizable cause. Passive congestion shows a dependence upon some other organic affection, and, although variable, is not progressive. They are thus distinguishable from advancing and more or less permanent disease of the kidneys.

TREATMENT.—For active congestion, cupping the lumbar region, abstracting blood according to the state of the patient. Purgation, by castor oil, or citrate or sulphate of magnesium. Then, the warm bath or hip-bath, continued for some time.

Uræmia.

DEFINITION.—The retention in the blood of the material which it is the function of the kidneys to excrete; from the suppression of their action.

SYMPTOMS.—When well-marked, headache, dimness of vision, vomiting, diarrhœa, convulsions, and stupor; ending in fatal coma.

PATHOLOGY.—The question as to what is the *immediate* toxic agent in uræmia is not yet fully determined; *i. e.*, whether it is urea, or an ammoniacal educt from its decomposition in the blood. In the absence of demonstration of the latter, the former is most probable. A further view has recently been urged; that it is unchanged creatin, creatinin, and other extractives, that contaminate the blood.

TREATMENT.—This must vary with the circumstances of the production of the suppression; but the great indication is to *depurate the blood*—by the kidneys if they can be restored to action, and by the aid or substitution of the bowels and skin. For this end, the warm bath, or the hot air, or warm vapor bath may be of great service. So may cupping or counter-irritation by mustard or tincture of iodine over the small of the back. Saline cathartics, even hydragogues, may be given to such patients as have strength to bear them; as cream of tartar, Epsom salts, elaterium, or croton oil; the last two most rarely. Lemonade drunk freely is often one of the best of diuretics. Others will be mentioned hereafter, in connection with dropsy.

Nephritis.

In the present state of urinary pathology, it is common to merge the topic of inflammation of the kidney (except suppurative pyelitis) as distinct from active renal congestion—in Bright's disease. If this be questionable as a matter of pathological system, it has at least practically no disadvantage; as the symptoms of nephritis are included in one or other of the affections named; and so is its treatment. We may submit therefore to the usage of authority upon this point, without hesitation. The symptoms of *acute pyelitis* (inflammation of the pelvis of the kidney) are essentially those of renal congestion, intensified; with tenderness on pressure over the kidney, and fever, until suppuration is established; then, purulent discharge for a variable time from the kidneys. Before pus appears, blood, in small quantity, mucus, and renal epithelial cells may be found in the urine. A tumor in one of the lumbar regions may precede for a while the escape of the pus. To such a state of things the term *pyonephrosis* is sometimes (though not desirably) applied. *Hydronephrosis* is a dropsical accumulation of water in the kidney.

Bright's Disease.

DEFINITION.—Albuminuria, dependent upon structural change in the kidneys; or, to speak, perhaps, more correctly, disease of the kidney, characterized by albuminuria and dropsy.

VARIETIES OR STAGES.—Authorities differ as to the discrimination of these. Bright believed there were three varieties. Dr. G. Johnson asserts two—the desquamative and non-desquamative nephritis. Frerichs considers them to be stages of the same affection, and admits three stages, essentially, of hyperæmia, exudation, and degeneration. Anatomically, we have the *large, smooth, white kidney*, the *small, smooth kidney*, the *granular uncontracted kidney*, and the *granular contracted kidney*. We may safely follow Roberts, in dividing Bright's disease, first, into *acute* and *chronic*. The latter is then divided into, 1. Cases which have lapsed from the acute state (smooth, white, generally large kidney); 2. Cases chronic from the beginning (granular, red, contracted kidney); 3. Cases associated with waxy or amyloid degeneration of the kidneys.

CAUSATION.—Bright's disease is one-third more common in males than in females. The greater number of cases occurs between the ages of 45 and 65. *Acute* Bright's disease is most often produced by cold and dampness; next by scarlet fever, pregnancy, or violent intemperance. The acute form is most common in early life.

Chronic Bright's disease is also greatly promoted by exposure to cold and wet; and is caused moreover by abuse of spirituous liquors, very often. Other predisposing causes are gout, constitutional syphilis, and affections of the bladder and urethra.

SYMPTOMS.—*Acute Bright's Disease.*—After exposure to cold, or a drunken fit, or scarlet fever, the patient is seized with chilliness, headache, nausea, vomiting, pain in the back and limbs, checking of perspiration, and oppression in breathing. Fever follows; and the face, trunk, and limbs become puffy with anasarca. Effusion may also occur into the pleura or peritoneum.

The *urine* is scanty, heavy, and dark in color, from the presence of blood; and very albuminous. The disposition to void it occurs more frequently than during health. The deposit from it, under the microscope, shows blood-corpuscles, loose renal epithelium, free nuclei, tube-casts, and shapeless masses of fibrin and *debris*.

After one, two, or three weeks, or even a longer period, the attack proceeds to one of three terminations: recovery, death, or lapse into the chronic state. Death results through uræmia, or from secondary pneumonia, pleurisy, peritonitis, pericarditis—or hydrothorax, œdema of the glottis, hydrocephalus, or ascites. Probably two-thirds or more of the cases of *acute* Bright's disease recover.

TREATMENT.—Cupping the loins, hot water or hot air or "blanket" bath, active purging, as with cream of tartar and jalap, or citrate of magnesium, and diaphoretics, as citrate of potassium or liquor ammon. acetat. Mercury is not recommended. The diet should be *liquid* and simply nutritious.

Chronic Bright's Disease.—This approaches so slowly as seldom

to be detected until after the lapse of months or years. Gradual loss of strength, pallor or puffiness of the face, shortness of breath, and frequent disposition to urinate, are early signs of it. But they are not always present; the *dénouement* of the disease may be by a convulsion, œdema of the lungs, amaurosis, or some violent local inflammation.

Fig. 293.

a a. Epithelial Casts; *b b.* Opaque Granular Cast; from a case of Acute Bright's Disease.

Symptoms of a well-marked case (not all present in every instance) are: albuminous urine, deposits of tube-casts and renal epithelium, dryness of skin, frequent micturition, especially at night, general dropsy, or local effusions into the cavities, indigestion, anæmia, uræmic effects (headache, dizziness of sight, convulsions, coma, vomiting, diarrhœa), enlargement of the heart, and secondary inflammations. Bronchitis is especially common.

The progress of the case is usually interrupted by exacerbations and intervals; each fresh attack leaving the patient manifestly worse than before. Such attacks much resemble acute Bright's disease; they are sometimes referred to known causes; the intervals may last weeks, months, or even years.

In PROGNOSIS, the tendency is always toward a fatal result. About one-third die of uræmic poisoning. A considerable number die of local dropsical effusions. One-fifth from secondary pneumonia, pericarditis, or pleurisy. The rest, by exhaustion from anæmia, indigestion, and anasarca, or the complications of apoplexy, cirrhosis, phthisis, intestinal ulcerations, etc.

DIAGNOSIS.—The presence of albumen in the urine, with dropsy, not of sudden origin or brief duration, is pathognomonic of this

affection. The tests for albumen, by heat and nitric acid, are readily applied. The microscope will show also free renal epithelium and tubular casts in the urine; in advanced cases, the casts are sprinkled with oil-dots. The solids of the urine, especially the urea, are reduced below the normal amount.

Fig. 294.

WAXY CASTS, FROM A CASE OF CHRONIC BRIGHT'S DISEASE.

PATHOLOGY.—Degeneration of the structure of the kidney induces albuminuria, by allowing the serum of the blood to pass almost unchanged through the cortical substance into the *tubuli uriniferi*. The deficiency of urea is due to the same impairment of secreting power. The consideration of the different varieties of renal degeneration would be too complex a subject for these pages. The reader is referred for it to the standard treatises on the subject.

TREATMENT.—The indications in every case of Bright's disease are—1. To hinder the progress of structural change in the kidney; 2. To prevent uræmia and secondary inflammation; 3. To palliate concomitant symptoms or states, as anæmia, dropsy, dyspepsia, etc.

Regimen or hygienic management is of the utmost importance for the first of these ends. Avoidance of exposure to cold, wet, or great fatigue; the reform of intemperance, if it has existed, or of other excesses—will be indispensable. Clothing should be sufficiently warm, with flannel next to the skin. Bathing frequently, at such temperature as is borne without either chill or relaxation, is to be recommended. The bowels should be kept regularly open. Nourishing diet, of which milk may generally be part, is of consequence.

Iron will do more good than any other medicine, unless it be cod-liver oil in persons of strong stomach. They may be very well combined. The tincture of the chloride of iron is as good as any other chalybeate, as a general rule. With some, the citrate of iron in solution, or a carbonate or the iodide, will agree more readily.

It is very doubtful whether astringents ever check to advantage the waste of albumen through the kidneys. If any be worth the trial, it is ammonio-ferric alum. Counter-irritants over the kidneys, unless of the mildest character (tinct. iodin., emplastr. picis, etc.), will not do any important good in *chronic* Bright's disease.

For the dropsy, warm baths and hydragogue cathartics are advised. Of the latter, cream of tartar and jalap, together, are the favorites: 2 to 3 drachms of the bitartrate with 10 to 20 grains of jalap two or three times a week. If serious dropsical accumulation threaten life, elaterium (gr. $\frac{1}{6}$ or $\frac{1}{4}$ every four hours, in pill, till it acts) may be given. But it is a decided mistake to harass the patient constantly with exhausting purgation. It is to be remembered that it can act only as a *palliative*, removing part of the *effects* of the malady, not the disease itself.

If the warm bath do not agree, or fail to produce diaphoresis, those who have access to it should try the *hot air bath*, at 130° to 150° Fah. This rarely fails to produce free perspiration. For weaker invalids, the vapor bath is available.

Of diuretics, acetate of potassium, spirit of nitrous ether, and infusion or compound spirit of juniper will be least likely to disappoint. But all will not unfrequently fail.

Then we have as a resource (where tapping for ascites is not demanded) for the relief of great œdema, the use of incisions with a lancet, or needle, in the swollen legs and feet. Some prefer a number of small incisions with an abscess lancet plunged through the skin of the calf and dorsum of the foot. It is possible that erysipelas may follow; but this danger will be lessened by repeated warm sponging of the limbs, washing them with diluted glycerin, or inunction with lard or cold cream.

The *complications* of Bright's disease must be treated according to their own indications, on general principles—bearing in mind always the *degenerative* and *asthenic* tendencies belonging to the malady itself.

Diabetes Mellitus.

SYNONYM.—*Glycosuria.*

DEFINITION.—Excessive urination, with the presence of sugar in the urine.

CAUSATION.—Twice as many men as women have this disease. It is most frequent among young and middle-aged adults; the mortality from it being greatest from fifteen to fifty-five. It is more common in cities and manufacturing districts than in the open country. Occasionally it is hereditary.

Exciting causes appear to be, exposure to cold and wet; drinking cold water largely when heated; excessive use of saccharine food; intemperance; violent emotion; febrile diseases; and organic affections and injuries of the brain and spinal cord.

Symptoms and Course.—Beginning insidiously, with malaise and slight loss of flesh, urination becomes excessive, with corresponding thirst, and very often *bulimia* or excessive appetite; emaciation is progressive; the skin harsh and dry; the tongue, glazed and furrowed, the mouth clammy; the sexual and mental powers fail by degrees. Lastly, hectic fever, œdema of the limbs, diarrhœa, and often all the symptoms of pulmonary consumption terminate the case.

Complications.—Tuberculization of the lungs occurs in nearly half the cases of diabetes mellitus which last over a year or two. Inflammations of an asthenic type are common in all the organs. Boils and carbuncles are very frequent. Gangrene of the lower extremities has been several times observed. Amblyopia (obscure vision) is present in about one-fifth of the cases. *Cataract* generally forms in cases of long standing; but may be absent altogether in those of less than two years' duration.

Diagnosis.—The detection of sugar in the urine, not temporarily, but for a considerable time, is of itself sufficient to make out the case. (See Chemistry.)

Prognosis.—Recovery is not impossible in diabetes; but a large majority of cases end in death. *Amelioration*—keeping the disease in abeyance—is often an attainable end. The younger the patient in whom the disorder begins, the less ultimate hope. In old persons glycosuria seems more often compatible with tolerable health for a long time. Cases traced to mental emotion or to injuries are somewhat more hopeful than those of indistinct origin.

Amblyopia, cataract, and albuminuria, as well as phthisical symptoms, mark the case as incurable. Considerable diminution of the sugar, or of the water, passed, is always a favorable prognostic. But the diabetic patient is much more liable than others to those inflammatory complications which, on slight exposure, may hasten the termination of life.

Treatment.—No direct control over the sugar-forming process in the body has yet been obtainable by medicine. But, although it would seem that simply diminishing the formation of sugar by withholding material for it ought not to be *expected* to do much good, it does prove beneficial. The most important measure yet devised in the management of diabetes is, the prohibition of sugar and starch, and of everything which can yield them, as food. Bread, except bran bread, which is almost free from starch, potatoes, and nearly all vegetables and fruits must be excluded. The safe exceptions are, the cabbage, broccoli, onions, spinach, celery, and lettuce. Of animal diet, milk and liver are forbidden articles. All meats, eggs and butter, and jellies are allowable. *Gluten bread* is made in France, on Bouchardat's plan, without starch, inflated by machinery with carbonic acid or compressed air. Tea or coffee may be sweetened with glycerin (chemically pure, as Bower's or Price's). Spirits, wines, and beer should be avoided unless called for by positive weakness; if that exist, the least saccharine should be preferred, as sherry, claret, or whisky, in minimum quantities. There is no advantage in restricting the amount of water taken to quench thirst. *Variety* of diet, of course, within

the prescribed limits, is important, to prevent disgust and loss of appetite.

Of medicines, *none* have been yet shown to do much service in checking the disease. The most positive influence in diminishing the diuresis belongs to opium; but this does not appear to interfere with the progress of the disease. Various drugs have been tried, and lauded greatly by different users; but their effects will not bear scrutiny without disappointment. Among them the most prominent are alkalies, yeast, rennet, pepsin, iron, quinine, creasote, alum, iodine, nitric acid, turpentine, and the inhalation of oxygen. Even free ingestion of *sugar* has been freely experimented with; but in vain. A therapeutic remedy for diabetes remains to be discovered.

Cystitis.

DEFINITION.—Inflammation of the bladder.

VARIETIES.—Acute and chronic; idiopathic, traumatic, secondary.

CAUSATION.—Blows or other injuries; the presence of gravel, or a calculus, or hydatid vesicles from the kidney; irritating diuretics; or decomposing urine retained by stricture, may induce acute cystitis. The continuation or frequent repetition of the same causes produces "chronic inflammation."

SYMPTOMS: *Acute Cystitis.*—Pain in the vesical region; frequent desire to pass water, with burning in the urethra, and *tenesmus*, or disposition to bear down or strain. There is fever, alternating with chills. The bladder may sometimes be felt as a small round swelling, sensitive upon pressure. In bad cases, there are nausea, anxiety, delirium, and cold perspiration; the scantily passed urine becomes purulent and bloody, alkaline and fetid.

Chronic Cystitis has usually much less severity of symptoms; but it may be very distressing from the tenderness and irritability of the bladder, and the frequent disposition to urinate, with dysuria. The urine is either mucous or muco-purulent.

TREATMENT.—*Acute* cystitis, with perfect rest, may need leeching or cupping above the pubes or (leeching) at the perineum. As a laxative, castor oil is apt to be the best. Warm hip baths will be very soothing. Flaxseed tea may be taken freely. Opium, hyoscyamus, or belladonna may be called for by great pain or nervous irritability. Opium or belladonna *suppositories* or laudanum enemata, will answer best if anodynes have to be repeated often. In *chronic* cystitis, local depletion is much less likely to do good. The other measures named may be suitable from time to time; also injections of lime-water and glycerin, or weak solution of nitrate of silver, or of sulphate of copper, or acetate of lead, in water or in glycerin, may be serviceable. *Catheterism* may at times be indispensable, both in acute and chronic cystitis; but it should be avoided if possible, on account of the mechanical irritation of the instrument.

For *Calculus* (Stone and Gravel) see SURGERY.

CHAPTER VII.

AFFECTIONS OF THE RESPIRATORY ORGANS.

Pneumonia.

Definition.—Inflammation of the substance of the lung.

Varieties.—According to its *seat;* single, double, lobular. According to *causation;* idiopathic, from cold and wet; traumatic, from injury; tuberculous, in phthisis; and typhoid pneumonia.

Symptoms and Course.—A chill or stage of depression, followed soon by fever, with oppression in breathing, dull pain (not always present) in the chest, and sometimes short cough. Delirium is common. Temperature of the body high, especially on the 4th or 5th day; sometimes, in the evening, reaching 104° or 105° Fahr. in the axilla. Secretions scant, as in other febrile states. Urine containing an excess of urea, but deficient especially in the chlorides, in the middle period of the attack. Expectoration commences about the third day usually, the sputa being composed of mucus, lymph, and blood mixed together, making the *rusty* sputum of pneumonia. In this an excess of chloride of sodium will be found by testing with nitrate of silver.

The height of the attack is generally reached between the 5th and the 7th day; after which the temperature declines, and, in favorable cases, all the symptoms subside. In others, oppression in breathing, and prostration increase; cough deepens, and expectoration becomes more abundant, at last purulent. Death seldom occurs before the sixth, and may be as late as the twentieth day.

Stages.—1st, that of congestion or engorgement, and the commencement of exudation; 2d, that of exudation and red hepatization; 3d, that of gray hepatization, softening, or purulent infiltration.

Physical Signs.—These differ in the three stages. In the first they are, moderate dulness of resonance on percussion over the affected lung, and, on auscultation, after the first day or two, the *fine crepitant* râle.

In the second stage, decided dulness on percussion, no râle, but, instead, *bronchial* respiration and bronchophony; with increased vocal fremitus. In the stage of softening or suppurative infiltration (gray hepatization), dulness on percussion, and coarse crepitant or mucous râle.

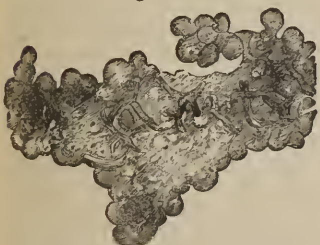
When *resolution* follows the second stage, as in most cases of recovery, the bronchial respiration gives way to returning fine crepitation (crepitus redux); and then the dulness of resonance on percussion also gradually disappears.

TERMINATIONS.—Resolution; death in the second stage from asphyxia; death from exhaustion in the third stage; recovery after the third stage (uncommon); abscess; gangrene of the lung.

MORBID ANATOMY.—The *lower* or *middle* lobe is almost always the seat of the disease. Should death take place (as it rarely does) in the first stage, the lung would be found somewhat swollen, dark-red, inelastic (splenization), and filled with blood or bloody serum. It will still float in water, though heavier than healthy lung. It is easily torn.

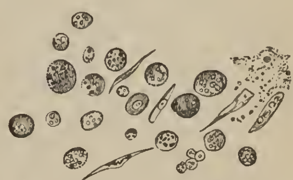
In the second stage, of hepatization, the lung is no longer spongy, but presents considerable resemblance to the liver; although a finger may be easily thrust through it. When entirely hepatized, it will not float in water, the air being displaced from the cells by the exudation of coagulable lymph.

Fig. 295.



LUNG IN STATE OF RED HEPATIZATION.

Fig. 296.



MICROSCOPIC CHARACTERS OF CONTENTS OF AN AIR-VESICLE IN GRAY HEPATIZATION: Granules, exudation corpuscles, pus-corpuscles, and epithelium.

The third stage consists in the degeneration (in the absence of more favorable *resolution* by absorption) of the exudation. This occurs by *granulation*, *softening*, and *suppuration*. Mostly the latter is infiltrated; occasionally an abscess forms. In gray hepatization, the lung is solid, impermeable to air, with a granite-like appearance of red and white points on section. It sinks in water, but is more easily torn or crushed into a pulp than in the second stage.

DIAGNOSIS.—The only affections with which pneumonia is likely to be confounded are pleurisy, bronchitis, and phthisis. In children, collapse of the lung has been mistaken for lobular pneumonia.

From pleurisy, it is known by the absence of the sharp pain belonging to the latter, and by the crepitant râle and rusty sputa. From bronchitis, by the dulness on percussion, râle, bronchial respiration, and bronchophony. From phthisis, by its sudden onset, fine crepitation, and sputa, as well as by the acute violence of the attack. Latent pneumonia sometimes complicates fevers, etc.

PROGNOSIS.—Simple pneumonia, of one lung, in a young and previously healthy person, ought, under favorable circumstances and judicious treatment, always to be recovered from. In the aged, it is dangerous; and double pneumonia is so at all periods

of life, though good recoveries do occur. It is double in about one case in eight.

Among the unfavorable signs—most of which are obvious—are expectoration of pure blood in the first stage, and albuminuria in the second.

Treatment.—This remains to be a *questio vexata*.

Probably five cases in six would recover without the abstraction of blood. Old persons and those of feeble system will neither bear nor require it.

Cupping between the shoulders may, in many cases, take the place of venesection; in some, it may follow this. The *early* administration of a vigorous purgative, as Epsom salts or citrate of magnesium, is proper, in the absence of any special contraindication.

Tartar emetic, in the dose of one-eighth to one-quarter of a grain for an adult, every two or three hours, may, according to many authorities, be continued during the height of the febrile stage. For this, as for bleeding, the indications are to be found not in the physical signs of pneumonia, but in the general condition of the system; not in the crepitant râle, but in the hot skin, hard or else oppressed pulse, pain and dyspnœa, and more or less darkly flushed face. After the height of the attack, small doses of ipecacuanha may be substituted for the antimonial; or nitrate of potassium, gr. x, every two hours. Dr. Todd preferred acetate of potassium.

Asthenic pneumonia requires a different treatment; and the same will apply to the third or suppurative stage of all cases. Support may be required, in a few cases, even from the first; by beef-tea, wine, or spirits (best with nourishment, as in punch), quinine, or ammonia. In hospital, some cases may recover under this plan *alone;* but they are the exceptions. Some cases, in which bleeding or cupping will be proper in the first stage, before the fourth day, may require beef-tea in the second stage, and quinine later. A large blister over the affected part is generally useful about the fifth, sixth, or seventh day of the attack.

Typhoid pneumonia is a term not always uniformly applied. It means, sometimes, or with some authors, inflammation of the lungs complicating typhoid fever; others include under it all cases of asthenic pneumonia. More generally, however, it designates that form of the disease in which epidemic or endemic influence has impressed a peculiar character. Malarial regions especially exhibit this, in the "winter fever" or typhoid pneumonia of our Southern States. Early and great debility, out of proportion to the local symptoms, with a tendency to low delirium, and to remittence, mark this disorder. In treatment, it bears little or no depletion, hardly the reduction of excitement by tartar emetic or veratrum viride. Diaphoretics first, as ipecac., $\frac{1}{2}$ a grain, with the same amount of calomel, and five or ten grains of nitrate of potassium, every three hours; or liquor ammonii acetatis, or solution of acetate of potassium; then quinine, when the need of a tonic is apparent, which may be very early; with strong liquid nourishment, and moderate counter-irritation; these are the measures usually proper in typhoid pneumonia.

Pleurisy.

DEFINITION.—Inflammation of the pleura.

VARIETIES.—Single or unilateral, and bilateral or double; idiopathic, traumatic, and secondary, *e. g.*, tuberculous, cancerous.

SYMPTOMS AND COURSE.—Generally, after a chill or cold stage, sharp pain in the side, impeded and accelerated respiration, short, sharp cough, and fever. The pain centres in the infra-mammary or lower axillary region; it is often intense, and is increased by a long breath, by coughing, pressure, or lying on the affected side. The pain and fever lessen after effusion has occurred; but the dyspnœa may then be increased. It is, after that period, most comfortable to lie on the diseased side, so as to allow of free breathing by the other lung. Acute pleurisy is often recovered from without any considerable effusion. When the latter does occur, absorption mostly follows. If not, life is endangered by interference with respiration. At first serous, constituting one form of *hydrothorax*, the fluid may become purulent; this is *empyema*. The term *false* empyema is sometimes given to a collection of pus in the pleural cavity from the rupture of an abscess in the lung. *Pneumothorax* is the accumulation of air in the cavity of the pleura; *hydro-pneumothorax*, of water and air together. Both of these are most common in tuberculous pleurisy, *i. e.*, in the course of a case of pulmonary phthisis.

STAGES.—In severe pleuritis there may be, 1, the adhesive; 2, the effusive; 3, the suppurative stage. In more favorable cases the 3d stage is that of absorption.

PHYSICAL SIGNS.—Of the 1st stage, deficient elevation of the ribs in breathing, feeble respiratory murmur on the affected side, and *friction* sound. 2d stage, dulness of resonance on percussion, bronchial respiration, bronchophony, sometimes *ægophony*. When the effusion becomes very copious, bulging of the side occurs, suppression of respiratory sound and of vocal resonance and vibration, with exaggerated or puerile respiration on the sound side. Displacement of the heart may take place if it is on the left side; of the liver if on the right. There is no physical sign by which empyema can be distinguished from serous effusion; but irritative fever usually accompanies empyema.

Absorption following extensive effusion allows *retraction* and *depression* of the chest on that side, from the slow or imperfect expansion of the lung. Then return, first, bronchial respiration and voice, or ægophony, and gradually the normal respiratory murmur. Sometimes, from adhesions of false membrane over the lung, permanent depression of the thorax on that side is left.

During effusion, its fluid character as well as extent may be shown by percussion in different positions. Sitting up, it falls forward, and rises to a higher line in front; lying on the back, the dulness, from gravitation, may fall much lower in the anterior region. Sometimes adhesions prevent this. *Succussion*, or sudden shaking of the chest of the patient, may produce an audible splashing, if the ear be over or near the affected side. By ocular inspection and measurement, the changes in the amount of the effusion may be estimated from time to time.

Morbid Anatomy.—In the early period, general redness and vascular injection of the pleura, with bands of whitish and more or less translucent or opaque coagulable lymph, causing adhesions of the pulmonary and costal pleura. Later, serous, sanguinolent or purulent effusion, in variable quantity, and sometimes displacement of the heart, lungs, and liver, and bulging of the ribs and intercostal spaces.

Diagnosis.—From pneumonia, pleurisy is known in the height of the acute attack by the sharpness of the pain, the friction sound, and absence of crepitant râle and of dulness on percussion. After effusion, especially by the change of the line of dulness with change of position, sitting and recumbent; by the bulging; and the degree of diminution of vibration of the walls of the chest when speaking.

From intercostal neuralgia, pleurisy is distinguished by the absence of fever and friction sounds in the former, and the non-increase of the neuralgic pain upon inspiration. Congestion, in some rare cases, attends neuralgia; the diagnosis is then more difficult. In intercostal muscular rheumatism, there is slight increase of pain in breathing deeply, but as much in moving the arms; and the pain is much less acute, and generally without fever.

Prognosis.—Pleurisy is rarely fatal; though death may occur, from very abundant effusion in bilateral pleuritis, or, with empyema in the unilateral, through gradual exhaustion.

Causation.—Exposure to cold and damp is the ordinary exciting cause of "idiopathic" pleurisy. Fracture of the rib, punctured wounds, etc., may cause traumatic pleurisy. In the course of phthisis, it not uncommonly occurs by extension of the disease from the lung. Cancer of the chest may produce it in an analogous manner.

Treatment.—In young and vigorous persons, more confidence may be placed in early antiphlogistic treatment than in pneumonia. Leeches or cups may follow, or be used instead of, venesection in doubtful cases. Tartar emetic, after a free purge, may be given, $\frac{1}{8}$ to $\frac{1}{4}$ of a grain every two or three hours, with $\frac{1}{2}$ to 1 grain of *opium*. Some practitioners add calomel, $\frac{1}{2}$ grain to 1 or 2 grains every two or three hours. When fever subsides, or vomiting occurs, the antimony should be withdrawn; the opium and calomel may be continued, while the pain lasts, carefully avoiding over-narcotism by the former, and salivation by the latter.

As soon as the heat of skin has considerably abated, if the pain continues, a large blister should be applied over the affected part.

For the effusion, diuretics, as squill, juniper berry infusion or compound spirit, acetate or bitartrate of potassium, etc., may be used. Iodine, in Lugol's solution, and iodide of potassium alone, are often advised. Repeated blistering sometimes has excellent effect.

When life seems to be threatened by exhaustion from dyspnœa, owing to large effusion not becoming absorbed, *paracentesis*, or puncture of the chest, is proper. Dr. Bowditch's plan is the best for this. He uses Dr. Wyman's apparatus, which is a trocar, with a silver canula having a stopcock, and capable of being connected

with a syringe by an intermediate piece, also having a stopcock, both cocks acting the same way. The operation is performed while the patient is sitting up, if able, or lying over the edge of the bed. The puncture is made somewhere between the seventh and tenth ribs, just behind their angles; making sure first of the position of the liver and spleen, so as to avoid them. Dieulafoy's pneumatic aspiration has been recently found to be an available method in thoracentesis.

In chronic cases of pleuritic effusion or empyema, the strength of the patient requires usually to be supported by good diet, and sometimes by tonics. This, in empyema, is often the most important part of the treatment.

Abscess of the Lung.

In rare instances, inflammation of the lung, active or *latent*, may terminate in abscess. Before rupture, dulness on percussion, bronchial respiration, and dyspnœa proportioned to the size of the abscess, are present. When an opening occurs, allowing the matter to escape into the bronchial tubes, the rather sudden commencement of purulent expectoration should attract attention. Then the physical signs of a *cavity* are discoverable by percussion and auscultation; amphoric or tympanitic resonance on percussion, cavernous respiration, metallic tinkling, etc., varying with circumstances. As is the case with pleuritic empyema, pulmonary abscess may communicate externally by a spontaneous opening.

The principal importance of abscess of the lung consists in the possibility of mistaking it for phthisis. The points of difference will be alluded to in connection with that disease.

Pulmonary Gangrene.

This may occur in pneumonia from extreme violence of the inflammation, or from a depressed state of the system; also, from cancer within the chest, pyæmia, etc. It is rare, but more common than circumscribed abscess of the lung. Unless very narrowly limited, pulmonary gangrene is always fatal. Its signs are, coarse mucous râle, taking the place of the vesicular murmur in the lower part of the lung, with copious brownish and offensively fetid expectoration, dyspnœa, and great prostration.

In bronchitis, occasionally, temporary fetor of the expectoration and breath may simulate gangrene; but transiently, and without the above symptoms.

The treatment of pulmonary gangrene must be, of course, supporting and antiseptic. Alcoholic stimulants, rather freely given, will be proper, with concentrated liquid food, as beef-tea. Sulphite of sodium (ten grains in solution every three hours) may be tried; or chlorine water, a teaspoonful or two every two or three hours.

Emphysema of the Lung.

This is dilatation of the pulmonary air-cells of one or both lungs. It may accompany prolonged asthma, or may follow chronic bronchitis. Its symptoms are, dyspnœa, and, when extensive, blueness of

Fig. 297.

EMPHYSEMA OF THE LUNG.

the lips, cyanosis, from interference with the circulation through the lungs; in many cases wheezing respiration. The physical signs are, bulging of the chest, increased clearness of resonance on percussion, and feeble inspiratory murmur with prolonged expiratory sound; sometimes displacement of the heart or liver. It is most easily mistaken for pneumothorax. But, in the *latter*, the resonance on percussion is more tympanitic, the inspiratory murmur still feebler, or quite absent, and there is no prolonged expiratory sound; besides which, the *concomitants* of pneumothorax usually serve to distinguish it.

Collapse of the Lung.

In hooping-cough or in severe bronchitis, especially in children, obstruction of a considerable air-tube may lead to an exhaustion of air from the cells supplied by it, and a return of that portion of the lung to the unexpanded condition (atelectasis) of fœtal life. The same state may occur in other conditions, from debility. It was formerly always mistaken for lobular pneumonia. It is usually fatal, unless very much limited.

Signs of it (often difficult of determination, however) are, moderate dulness on percussion, with absence of the murmur of respiration; and, in some cases, an inward motion or recession of the lower ribs during the effort at inspiration.

Bronchitis.

VARIETIES.—Acute and chronic; general, capillary; plastic, rheumatic, and syphilitic bronchitis.

SYMPTOMS AND COURSE.—Systemic depression, followed by fever; tightness and soreness of the upper and anterior part of the chest; cough, at first short, dry, and tight, later, deeper and looser, with expectoration; the latter being at first mucous, in rare instances pseudo-membranous, in severe cases at a late stage purulent.

Capillary bronchitis is marked by greater dyspnœa and tendency to early depression and prostration.

Chronic bronchitis is often free from febrile symptoms, the cough and expectoration, with slight dyspnœa, characterizing it.

PHYSICAL SIGNS.—No dulness on percussion, except in case of collapse of part of a lung from obstruction; sonorous rhonchus and sibilus, generally, though not quite always, on both sides of the chest; varying from time to time, in seat, character, and loudness. In capillary bronchitis, extended mucous, crepitant, or subcrepitant râles, closely resembling the fine crepitation of pneumonia.

DIAGNOSIS.—No difficulty exists except in distinguishing chronic bronchitis from phthisis. Absence of dulness on percussion and of the signs of excavation, are most important; the expectoration also is whiter and of less weight in bronchitis; and there is no hectic fever.

PROGNOSIS.—Acute bronchitis is dangerous in old persons and young children; seldom fatal in vigorous middle life. The capillary form is always most serious; death taking place sometimes from the 10th to the 12th day. Chronic bronchitis is not often fatal, even by exhaustion; but it may last an indefinite time, even many months.

TREATMENT.—Abortive treatment of a "cold on the chest" may sometimes be effected within the first twenty-four hours, by taking, at bedtime, a glass of hot lemonade or ten grains of Dover's powder after a warm mustard foot-bath. Should this fail or be omitted, a brisk saline purgative should be given, of Epsom or Rochelle salts, or citrate of magnesium. Then, when the fever is high, cough very tight, and breast sore, tartar emetic should be advised, $\frac{1}{8}$ to $\frac{1}{4}$ grain every two or three hours, with frequent draughts of flaxseed tea or some similar demulcent. A large sinapism over the upper sternal region will aid in giving relief; and so will friction with oil of turpentine.

In milder cases, or where the strength of the stomach is doubtful, syrup of ipecacuanha, $\frac{1}{4}$ to $\frac{1}{2}$ drachm every two or three hours, will answer; and it should be continued until the cough softens and the breathing becomes easier. Then syrup of squills may follow, in fluidrachm doses, every three or four hours. When the cough is troublesome at night $\frac{1}{2}$ to 1 fluidrachm of paregoric may be added at bedtime; or through the day, occasionally, if coughing be very violent or frequent. Opiates do the most good, however, *after* some *loosening* of the cough with free expectoration. When the fever has abated, and especially if dyspnœa continue, a blister may be applied over the sternum.

In capillary bronchitis, or in the ordinary form in the aged and feeble, instead of tartar emetic the more stimulating expectorants may be required, as senega, in decoction or syrup, chloride or carbonate of ammonium, with quinine and beef-tea, wine-whey, or whisky-punch. Inhalation of steam, alone, or from infusion of hops, sometimes soothes the air-tubes advantageously.

Chronic bronchitis requires persevering use of counter-irritation over the chest, by croton oil (3 drops with the same of sweet oil applied nightly till a papular eruption follows), painting with tincture of iodine, plaster of Burgundy pitch, hemlock, etc., an alternation of stimulating and alterative expectorants, and tonics. Besides squill and senega, ammoniacum, copaiba, and chloride of ammonium are most frequently useful. If the system be below par, quinine, iron, and cod-liver oil are important. When secretion is very copious, inhalation of tar-vapor or of creasote should be tried. The former may be used by putting an ounce or two of tar in a cup over boiling water; so as to diffuse the tar-vapor through the chamber. Creasote, 20 or 30 drops, may be put into half a pint of boiling water, to be breathed by means of an ordinary inhaler. When medicine fails, change of air will sometimes entirely cure.

Asthma.

Definition.—Paroxysmal and spasmodic dyspnœa.

Varieties.—*Idiopathic* and *symptomatic; dyspeptic* asthma; *hay* asthma.

Symptoms and Course.—Every night, or once a week, month, or year, or at irregular intervals, the attack comes on. Most frequently it is between 1 and 3 o'clock in the morning. Premonitory symptoms often are great drowsiness, or wakefulness, headache, flatulence, itching under the chin. Dyspnœa is then the characteristic symptom. The sufferer sits or stands up, leaning forward, and labors to breathe. The chest is expanded to its utmost, by the accessory as well as principal inspiratory muscles. The countenance is anxious, with pallor, coldness, and in severe cases lividness, of the face and hands. Perspiration is often copious. A wheezing sound accompanies respiration; giving way finally, with relief, upon the expectoration of mucus, usually rather thick, and in pellets.

The attack may pass over in a few minutes, or may last for hours, or, with some remission, days or weeks. Where asthmatic symptoms are persistent, as is not very uncommon, for years, some structural change in the organs of the chest exists; it is then *symptomatic* asthma.

Physical Signs.—Inspection shows unusual elevation of the ribs and shoulders. Placing the ear on the chest, sonorous and sibilant sounds, loud but mostly small in calibre, are found to take the place of the respiratory murmur. These sounds change their locality frequently. As the attack gives way, with expectoration, some mucous râle is heard.

Special exploration is necessary in each case to determine the presence or absence of pulmonary or cardiac complications.

Prognosis.—Death almost never occurs during the fit of asthma.

Those subject to it often live to old age. But dilatation of the pulmonary air-cells, and enlargement of the heart, may follow in protracted cases, breaking down the health.

Pathology and Nature.—It has been made certain that asthmatic dyspnœa is owing to a spasmodic constriction of the smaller bronchial tubes, by tonic contraction, mostly reflex, of their involuntary muscular fibres.

Causation.—Asthma is hereditary in a majority of cases. Males have it more often than females. It may occur at any age.

Treatment.—During the attack, our aim must be to give relief, by relaxing spasm. Ipecacuanha wine, with tincture of lobelia, one-quarter to one-half fluidrachm of each every half-hour until nausea or expectoration is produced, I have known often to act very well. Hoffmann's anodyne, in one-half drachm or drachm doses, will sometimes do great good; and so may hydrate of chloral, in doses of from twenty to forty grains. Some practitioners advise hyoscyamus, musk, and hydrocyanic acid. Smoking tobacco is relieving in some instances; smoking cigarettes of stramonium leaves, in others. More still find comfort in breathing the air in which are burned papers which have been soaked in a

saturated solution of nitrate of potassium. Inhalation of ether or nitrous oxide may be carefully used in extreme cases. As an adjuvant, the warm mustard foot-bath may be employed; as well as sinapisms or dry cupping between the shoulders.

Between the attacks, endeavor should be made to rectify digestion and its tributary processes, and to invigorate the nervous system. Some cases will require blue pill, nitro-muriatic acid, or taraxacum, bitter tonics and mild laxatives, such as rhubarb, etc. Others need iron and quinine. Iodide of potassium is highly recommended by some; conium, cannabis indica, and arsenic in small doses by others. There is reason for giving trial to the bromide of potassium in obstinate cases; most patients will bear from 10 to 20 grains of this twice or thrice daily for weeks together without inconvenience.

Prophylaxis.—No disease is more curiously capricious in its causation than asthma. Some always have a paroxysm if they visit the sea-shore; others are more secure there than elsewhere. One cannot sleep on the first floor; another does better there than higher up. Each must learn his own peculiarities, and be governed thereby.

Most remarkable are the annual attacks of *hay* asthma, *summer catarrh*, or asthmatic bronchitis, to which a few individuals are subject.

In asthmatic persons generally, nothing is more important than prudence and regularity in diet and regimen.

Bronchial Dilatation.

This, of which extreme degrees are not common, is of interest chiefly because it is possible for it to be mistaken for phthisis. There are two forms; the tubular and the saccular enlargement.

In either, slight dulness on percussion may occur, from condensation of the lung around the expanded part. Sonorous rhonchus and coarse mucous râle

Fig. 298.

Dilatation of the Bronchi.

exist, the latter especially in the saccular form. In this, the signs are almost identical with those of tubercular excavation; but they occur usually at the middle or lower part of the lung, and are stationary, as they are *not* in tuberculization.

Cough, very troublesome, and attended by copious mucous or slightly purulent expectoration, is common in bronchial dilatation. The palliation of this symptom, with care of the general condition of the patient, is all that can be accomplished for it in treatment.

Laryngitis.

Slight inflammation or congestion of the mucous membrane of the larynx is very common as the result of cold; its signs being hoarseness, with a dry, short, harsh cough, and some soreness in drawing a breath. But simple acute laryngitis of severe grade is quite a rare affection.

When it occurs, there is fever, with hoarseness, "brassy" cough, distressing dyspnœa, and difficulty of swallowing. *Œdema glottidis*, or submucous effusion of serum, contitutes the greatest danger in laryngitis; the swelling obstructing respiration to a degree often fatal. This disorder is almost exclusively met with in adults.

Early purging, the application of leeches, the internal use of ipecac, in doses just short of nausea, with moderate quantities of opium, and the frequent inhalation of the steam of boiling water, constitute the best treatment. If dyspnœa become decidedly serious, threatening asphyxia, tracheotomy is advised. Some account of this operation will be given in connection with Croup.

Œdema of the glottis may be produced immediately by the ingestion of boiling water, or of sulphuric or nitric acid. This has often accidentally happened.

Chronic laryngitis, with ulceration, is a not infrequent attendant of phthisis. Some cases of the latter begin with it; in others it occurs somewhat late in the course of the disease. Syphilitic ulceration of the larynx is tolerably common, as a secondary symptom. This, as well as polypi or other tumors of the larynx, may be discovered, and treated by operation for removal, or with solutions of nitrate of silver, etc., with the aid of the laryngoscope.

The confidence of many physicians in the utility of very strong solutions of nitrate of silver in chronic inflammations of the mucous membranes, of the throat or elsewhere, has not increased, in fact has not been sustained, by what has been seen in practice. Dr. Horace Green and others have made frequent use of it of the strength of sixty grains to the ounce. Except for *ulceration*, which may benefit even by the solid caustic, from four to ten grains in the ounce of water will do more good, in almost all cases, than the stronger proportions.

The application of *nebulized* liquids, by apparatus for *atomization*, is now much in vogue in both acute and chronic laryngitis. Some remarks upon this will be made hereafter.

The Laryngoscope.

The apparatus required for laryngoscopy consists of a laryngeal mirror, an illuminating mirror, and a tongue-depressor. Glass or polished metal may do for the mirrors.

The laryngeal mirror may be round or square, preferably the former; and about an inch or less in diameter. It should be attached at an obtuse angle (120° to 125°) to a stem, which may be fastened into a slender handle so as to be drawn out or pushed in.

The illuminating mirror is larger (from 3 to 12 inches in diameter) and concave, to concentrate reflected light. It may be held by a handle in the operator's mouth, or fixed by a band to his forehead, or, best, as used by Semeleder, perforated in the middle and fastened to the bridge of a pair of spectacles (with or without the glasses) so as to rest before one of the eyes and be looked *through*.

The laryngeal mirror is introduced (after being *warmed* to prevent condensation of moisture) so that its back pushes the uvula upwards and backwards, its lower edge presses upon the posterior wall of the pharynx, and its stem rests in the angle of the mouth.

Sunlight, horizontal (morning or evening), is the best for laryngoscopy, but artificial light, as of a good lamp, may suffice.

The *difficulty* of the operation is produced by the *irritability* of the fauces and larynx. Few can allow of a successful examination on the first attempt; practice makes tolerance. To hasten this, bromide of potassium has been given by some. The frequent insertion and retention for a while of the finger of the patient, or of an instrument, in the fauces, accustoms the parts to pressure. Holding ice in the throat just before the examination, also lulls sensibility.

By laryngoscopy, tumors, ulcerations, inflammatory changes, etc., in the larynx may be inspected, topical applications, as of nitrate of silver, made, and surgical operations performed, with a precision not otherwise possible.

Rhinoscopy is the examination, in a similar manner, of the *posterior nares*. It requires merely a *smaller* mirror (less than three-fourths of an inch in diameter) than for laryngoscopy, and at about a right angle to its handle.

Aphonia.

Loss of voice may be transient or permanent; and either functional or structural in its origin. Especially in hysterical females, a nervous shock may produce a *paresis* or enfeeblement of the vocal power, lasting often for days together.

Faradization, *i. e.*, the use of induced electrical currents (as magneto-electricity), carefully applied, has sometimes cured nervous or hysterical aphonia. Vesication of the back of the neck may be useful for it.

Congenital dumbness, except in idiots, is due to deafness, making the learning of speech impossible, unless by a recently invented system of instruction by sight.

Organic or structural aphonia is caused by lesions of the larynx,

such as ulcerative destruction of the vocal cords, tumors, etc., which are to be diagnosticated by laryngoscopy.

The term *dysphonia clericorum* has been applied to an affection of the throat not uncommon among clergymen and other public speakers, called by Dr. Horace Green "follicular disease of the pharyngo-laryngeal membrane."

A conventional treatment for this affection has been the application every day or two of a solution of nitrate of silver, with a brush or probang. Saturated solution of tannin is also used for it. If these local remedies do not relieve in a week or two, the frequent swallowing of small pieces of ice, or gentle gargling several times a day with ice-water, may be substituted with advantage. Counter-irritation of the throat, especially by croton oil, should, if necessary, be persevered in for a considerable time. Three drops of the oil (diluted with as much sweet oil for a delicate skin) may be rubbed over a limited space in front of the throat every night until a papular eruption comes out.[1]

Many cases of this complaint are as much constitutional as local in origin. Where real dysphonia (difficulty or imperfection of vocalization) exists, public speaking or singing must be avoided to allow the organs repose. Tonics and change of air may often prove the best measures of treatment.

Laryngismus Stridulus.

This is an infantile affection, consisting in spasmodic closure of the glottis, causing a stridulous or shrill whistling respiration. It is more apt to occur during dentition, but is not very common. Its onset is sudden, and duration brief. Though exceedingly alarming, it is seldom fatal.

The treatment must be prompt; applying a sponge wrung out of hot water to the throat, and putting the feet into hot water, to produce derivation and diffusive stimulation. In severe cases mustard plasters (diluted with flour) may be applied to the chest and back. Some advise the momentary inhalation of ether or chloroform. When life is really in great danger from prolongation of the spasm, tracheotomy may be justifiable. Children who have laryngismus are generally anæmic; requiring iron and salt baths.

Croup.

We understand by croup, an acute cynanche or angina, whose signs are, a hoarse cough, difficult and audible respiration, and aphonia; the seat of the disorder being the upper portion of the air passages. Its place in nosology has been empirically or conventionally (rather than systematically) established.

For brevity's sake, the following propositions may be advanced:

1. The pathological elements of croup are, *a*, spasm; *b*, hyperæmia or congestion; *c*, inflammation, either ordinary or diphtheritic.

The spasm affects especially the muscles whose action tends to

[1] Patients should be cautioned, of course, against allowing the oil to come near the eyes. I have known a severe ophthalmia to result from neglect of this.

close the rima glottidis; but may involve also the muscular coat of the trachea itself.

The hyperæmia commences in the mucous membrane of the larynx or trachea, but often extends throughout the whole anterior cervical region.

The inflammation may be located in a small portion of the same mucous membrane, or, it may extend downwards indefinitely into the bronchial tubes.

2. We may mentally distinguish between cases in which the croupal dyspnœa results from simple spasm, from simple tumefaction, or from inflammation without any spasmodic constriction of the glottis. But in practice the pathognomonic cough and breathing rarely attend such an isolation of one of these conditions. A certain number of cases, however, occur, of purely spasmodic or nervous croup; now and then substituting more general convulsions; as when worms have been apparently an exciting cause. A purely inflammatory case is at least equally rare. In fatal pseudo-membranous cases, autopsic examination has repeatedly shown that the amount of false membrane was by no means sufficient, alone, to have occluded the larynx or trachea; the result being due to the additional *spasmodic contraction.*

3. The most frequent form of the disease, common night croup, is pathologically characterized by spasm of the glottidean apparatus, with congestion and tumefaction (transient in character), of the laryngo-tracheal mucous membrane.

It is in these respects precisely *analogous* in nature to the asthmatic attack, whose seat is in the smaller bronchiæ. There is no strongly-marked line of separation between this form and the *catarrhal croup*, or croupal catarrh, in which more or less active inflammation occurs, prolonging the existence of the symptoms.

4. Looking then on the hyperæmic state as simply intermediate, we may classify the cases of croup, as they ordinarily occur, clinically, as, 1st, those in which spasm predominates; and 2dly, those in which inflammation is the dominant condition; or, bearing in mind the above expressed qualification, into spasmodic and inflammatory cases.

5. Pseudo-membranous, or "true croup," does not generically differ from inflammatory croup; of which it is only a grade or termination: *i. e.*, any case of inflammatory or catarrhal croup *may* end in the exudation of coagulable lymph within the air tubes.

6. Whether this shall occur or not, in any given case, depends, *a*, on the degree of the inflammation; *b*, on the state of the blood of the patient; *c*, on the treatment.

7. It cannot be predicated on the ground of experience, that either vigorous and plethoric, or feeble and anæmic children, are especially prone to the membranous form or termination of inflammatory croup. It may and does occur frequently in both.

8. The ordinarily recognized signs for the diagnosis of inflammatory from non-inflammatory croup, are sufficient, viz., the persistent duration of the croupal cough and voice—the (generally) slow onset—the febrile symptoms—and the *stridulous* inspiration, as the dyspnœa increases.

9. Inflammatory or true croup is, with the above inclusion (as

always potentially membranous), not at all necessarily fatal, although highly dangerous. The presence of the false membrane itself does not inevitably determine a fatal result.

10. In no disease does more depend on *early treatment*, which is often prevented by the insidious approach of the attack, deluding the parents. The mortality of the disease may thus in part be accounted for.

Fig. 299.

FALSE MEMBRANE.

Fig. 300.

FALSE MEMBRANE.

Fig. 301.

FALSE MEMBRANE OF THE BRONCHIAL TUBES.

11. In the treatment of all forms of croup, *relaxation* and *secretion* are the two great desiderata.

12. In the spasmodic cases, emetics and antispasmodics (*e. g.*, ipecacuanha, onion, assafœtida, or lobelia) will effect these objects, especially if added by the warm bath or foot bath.

13. In mild inflammatory cases, saline purging, gentle vomiting, and the use of demulcents, counter-irritation, and pediluvia will relieve.

14. In the more active cases, the loss of blood by the lancet, or by leeching, or by both, may be proper, and should be *early* used. Venesection is, however, rarely practised at the present day.

15. The most satisfactory emetic for employment in severe cases is a combination of ipecac and alum, the latter being used in half teaspoonful doses in urgent cases, until emesis is produced. Nor should the practitioner hesitate to compel repeated vomiting at intervals, in desperate cases.

16. Tartar emetic should not be used as an emetic in croup ; in sedative or expectorant doses, it may be advantageous.

17. Calomel freely administered, that is, a grain every hour or two, has the highest authority in its favor, in serious croup.

18. Nitrate of potassium has both experience and reason in its favor. Being a solvent of fibrin, it should tend to prevent the excessive coagulability of the exudation. According to late theories, ammonia might do the same thing ; but the clinical or therapeutic antecedents of ammonia point otherwise.

19. The great evil in membranous croup is the solidifying tendency of the exudation ; why should not, therefore, an abundant imbibition of fluids, even of water, do something towards the counteracting of this ? Inhalation of steam, from hot water poured upon unslaked lime, is eulogized by several recent writers. Glycerin, in teaspoonful or half teaspoonful doses, is recommended by others.

20. No clear indication exists for the use of opium in the majority of cases of inflammatory or membranous croup ; although it may become useful, in cases which are protracted, or which are attended by a more than usual disposition to spasmodic symptoms.

21. Blisters are decidedly useful ; but they should not be left on long in croup, a superficial vesication only being desired.

22. The application of a strong solution of nitrate of silver to the fauces (and larynx, if possible) does good in many cases ; in the pre-exudative stage, as a medicament ; in the exudative, as a mechanical operation aiding to dislodge the membrane.

23. Iodide of potassium is too slow in its systemic action to be relied on ; and the same may be anticipated of the bromide, although nothing should forbid their fair trial.

24. Tracheotomy or laryngotomy will, when performed early, succeed in a fair number of cases ; but in those very cases it is impossible to know that they (as well as those in which it fails) might not have recovered without it. Few practitioners, therefore, in this country, can demand the operation early ; and in the moribund state, the vascular congestion, from asphyxia about the throat, renders success extremely difficult, sometimes impossible.

Dr. C. West, who has had but one recovery in sixteen cases, was obliged to admit its success, in some otherwise hopeless instances ; especially in France, where Trousseau and others operate earlier than in England or here. It is most generally fatal in children under three years of age. Where there is reason to suppose the membrane to extend into the bronchial tubes, it is of course in vain. The danger of hemorrhage is least if the operation is early.

If performed, it should be deliberate, making a considerable opening in the trachea, and inserting a tube or canula of good size.

Then the patient should be surrounded constantly with a warm, moist atmosphere. The canula should be withdrawn in as few days as possible, upon the return of permeability of the larynx. The wound may then be treated with ordinary mild dressings to exclude the air and heal it up.

Lately, the fact that lime will dissolve false membranes has been applied to the treatment of croup; by making the patient breathe the steam from boiling water poured over unslaked lime. Although the lime is not volatile, some of its minute particles will be raised mechanically by agitation. Several successful cases of its use are reported.

Pleurodynia.

SYNONYM.—*Intercostal Rheumatism.*

SYMPTOMS.—Pain, generally rather dull, sometimes quite severe, of one or both sides, oftenest on the left. It is increased by deep breathing or coughing, moving the arms or trunk.

DIAGNOSIS.—From pleurisy, it is known by the absence of fever, and of all modifications of the sounds heard upon percussion and auscultation.

TREATMENT.—A large mustard plaster over the part; friction with soap or volatile liniment; dry or cut cups; a blister, or the hypodermic injection of morphia, if obstinate as well as severe.

Phthisis Pulmonalis.

DEFINITION.—Caseous or tuberculous consumption of the lungs.

VARIETIES.—Acute, chronic, and latent phthisis.

SYMPTOMS AND COURSE.—Consumption may begin after a severe acute bronchitis or broncho-pneumonia; or, more gradually, with an apparently slight hacking cough; or with a hemorrhage; or with dyspepsia and general debility; or with chronic laryngitis. Increasing, in most cases slowly, the pectoral and constitutional disorder becomes developed. We have then pains in the chest, frequent and severe cough, hemorrhage occasionally (in about two thirds of the cases) and pallor, acceleration of the pulse and elevation of the temperature, with the paroxysms of hectic fever. *i. e.*, chills followed by fever with bright flush of cheek but without headache; emaciation, arrest of menstruation in the female, night-sweats, colliquative diarrhœa; finally, often, though not always, delirium; and death, mostly by exhaustion, but sometimes by suffocation. The spirits of the patient are apt to be cheerful, even hopeful of life almost to the last. Appetite is variable, digestion usually not vigorous; but to this there are exceptions.

The expectoration in phthisis is at first mucous or bloody; later, muco-purulent and bloody, or else *nummular; i. e.*, in roundish masses like coins, not floating perfectly in water; or, abundant and purulent.

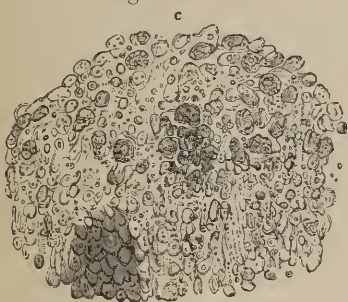
STAGES.—These are, 1. Incipient phthisis; 2. The stage of consolidation of the lung; 3. That of excavation or *vomicæ;* 4. Advanced or confirmed consumption.

PHYSICAL SIGNS.—Is there a *pre-tubercular* stage of phthisis? If so, it cannot be certainly pronounced upon. The earliest indications upon physical exploration are, a sinking in under the

clavicle upon the left side, with prolonged expiratory sound. Not long after, the evidence of consolidation is, increased dulness over the apex of the lung upon percussion (not invariably but *generally* upon the left side) with blowing or bronchial respiration, or interrupted jerking respiratory murmur, and increased vocal resonance and vibration. Dry crackling follows, with mucous or coarse crepitant râle.

When softening of tubercular deposits occurs, moist crackling and gurgling become very distinctive signs. The pressure of a *vomica* is shown by cavernous respiration and bronchophony or pectoriloquy. Percussion resonance over the cavity will be dull if its walls be thick, and amphoric if they are thin and tense; if thin and relaxed, the *bruit de pot fêlé*, or cracked-pot sound. On percussion over a cavity when the patient's mouth is shut, the sound produced will be of a lower pitch than when the mouth is open.

Fig. 302.

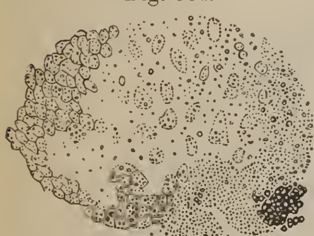


YELLOW TUBERCLE; CRUDE MASS.

Fig. 303.

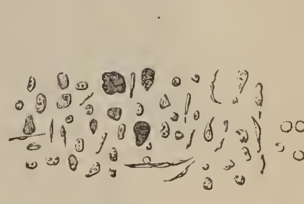
GRAY TUBERCLE, MILIARY GRANULATION.

Fig. 304.



TUBERCLE CORPUSCLES, GRANULES, AND MOLECULES; from a softened lung.

Fig. 305.



ISOLATED TUBERCLE CORPUSCLES. On the right, four blood corpuscles.

Pneumothorax and hydro-pneumothorax, *i. e.*, dilatation of the pleural cavity and compression of the lung by air, or air and liquid together with perforation of the lung, are not uncommon results of tuberculization, although possible without it. Of pneumothorax,

the percussion resonance is tympanitic; respiratory murmur lost. Hydro-pneumothorax may give tympanitic resonance above, with metallic tinkling on ascultation, and dulness below.

PHYSICAL AND MICROSCOPICAL PECULIARITIES.—Temperature has of late been found to be a diagnostic aid in phthisis. It is asserted that there is a *continued elevation of the heat of the body* in all cases in which tubercle is being deposited; that this may occur four weeks before any local physical sign is discoverable; and that the rise in the heat of the body varies, during the progress of the case, with the greater or less activity of tuberculization. Exceptions occur, however, to the truth of this statement.

When expectoration is copious, some micrologists aver that the diagnosis may be aided by its minute characters; arched and anastomosing fragments of pulmonary fibrous tissue, and tubercular corpuscles, being discerned. But it is not certain that the former are only thrown off in phthisis; and the latter may be absent or obscure in character in an otherwise clear case of consumption. Dr. Fenwick, of London, detects minute portions of lung-tissue by boiling the expectoration a few minutes with its bulk of solution of caustic soda (gr. xv in f℥j of distilled water), and then adding cold water in a conical vessel. The sediment is then examined with the microscope.

TERMINATIONS.—The cicatrization of vomicæ, and the cessation of tubercular deposition, have, although exceptional, been often found to occur; and so have the cornification and calcification of unsoftened tubercle. Recovery from phthisis may in such cases be expected to take place, as the arrest of the local disease only attends the presence of a favorable constitutional state.

Fig. 306.

APEX OF A TUBERCULOUS LUNG, WITH CAVITIES.

Death from consumption may come by *asthenia* or by *apnœa*. The first is most common. Suffocation or apnœa may follow—1, from hemorrhage; 2, rupture of a large vomica; 3, pulmonary

œdema or hydrothorax; 4, excessive secretion or bronchorrhœa, beyond the power of expectoration.

PROGNOSIS.—Phthisis is certainly one of the most destructive of diseases. In no case can recovery be anticipated; but it does occur, as every physician must have witnessed. I have seen a number of such recoveries; generally from the incipient stage, but even where vomicæ, emaciation, and night-sweats had occurred. Dr. A. Flint has recorded the history of sixty-two cases of restoration from consumption.

Under improved hygiene and medical treatment, the mortality from phthisis appears to be declining.

The *duration* of phthisis varies greatly, being least, as a general rule, in the youngest subjects. Eighteen months to two years is the most frequent period. But in some instances life is prolonged under it for twenty, thirty, or even forty years.

Acute phthisis, or galloping consumption, may end life in from six weeks to three months. This sometimes follows pneumonia. Its symptoms differ from those of ordinary consumption chiefly in their rate of progress. Softening of tubercle and the formation of cavities do not always occur to any extent, apnœa being caused by extensive diffusion or infiltration of the caseous or tuberculous deposit through the lungs.

CAUSATION.—Hereditary taint of constitution is general; independent origination of phthisis the exception. From 18 to 35 years is the time of life most subject to it; but it is now and then met with even in children, and frequently in the aged. Statistics in Europe and this country show some proportion between the mortality from consumption and nearness to the sea level; the lowest lands having the greatest total amount of it. High, dry, and equable climates and situations, even though cold, are most exempt from it. It is not a disease of the Arctic regions, and there is more of it in Tennessee than in Illinois.

Individually, and in families, all causes that depress vitality promote it; but most of all *impure atmosphere* and *dampness of locality*. Sedentary employments and exhausting excesses, with foul air, make large cities most of all productive of it. In constitutions having the proclivity towards it, tuberculization may be brought on by any reducing disease, especially such as involves the breathing organs; as measles, bronchitis, or pneumonia.

PATHOLOGY.—Since Laennec, it has, until recently, been the accepted doctrine that true phthisis was always a *tubercular* disease; whatever inflammatory and hemorrhagic symptoms occur in it being results of the deposition and changes of tubercles, either yellow or gray, in the lungs or elsewhere. Within a few years, however, a different view has met with much favor in the profession, under the teaching of Virchow, Oppolzer, Niemeyer, and others. According to these authors, *catarrhal or caseous pneumonia* may be, or may become, when prolonged, phthisis pulmonalis, without any tubercular deposit. Secondary deposition of tubercle may occur; it is sometimes asserted (Buhl) that true tubercle is always secondary, depending on the absorption (resorption) of the caseous product of inflammation. Many pathologists now deny the tubercular nature of the yellow infiltration, so regarded

by Laennec; insisting that only the miliary transparent and opaque granular matter are really tubercles. This whole subject is now undergoing special investigation. The production of tubercle in animals by *inoculation* is asserted by a number of authors. Tuberculosis of the lungs has, in some experiments, followed inoculation with pus, and other morbid products, as well as with tubercle; showing that it is not precisely a *specific* pathogenetic process.

Treatment.—*Hygienic management* is, decidedly, more important to the consumptive than medicine.

Altogether, the *analeptic* principle is now universally adopted for the treatment of consumption. The diet must be nourishing; a "generous" regimen; and the same indication is to be followed in the employment of medicines.

There has been discovered, as yet, no specific to arrest tuberculosis. But cod-liver oil and alcohol, and, in lesser potency, iron, quinine, nitric acid, and other tonics, in a certain number of cases do manifest an important conservative and restorative influence; and palliation of symptoms, as pain, cough, loss of rest, may greatly help the comfort of the patient.

Unfortunately, however, in quite a considerable number of persons the stomach turns against cod-liver oil. When that is the case, it is quite in vain to urge it. Milk may partly take its place.

Alcohol, though variously estimated by different physicians, is well established as a remedial or at all events a supporting agent of value in consumption. Not to be used in excess, nor ever to produce excitement in any degree; but simply as a *roborant;* as an addition to the diet and a supporter of the strength of the invalid. The dose must, therefore, be proportioned to his condition.

Whisky is preferred by many; but ale, lager beer, and wine suit different patients best. A little two or three times daily will be better than a full drink at one time. Always begin with very small quantities—say two or three teaspoonfuls of whisky, or half a glass or even less of wine, or half a tumblerful of ale or beer. To do good, the stimulant *should not quicken the pulse, flush the face, or be felt to affect the head.*

When it can be done, alcoholic stimulus is best given with nourishment, as in milk, or beaten up with a raw egg, etc.

Beef-tea,[1] as a concentrated nutrient, is very useful when digestive power is low, at any stage of phthisis.

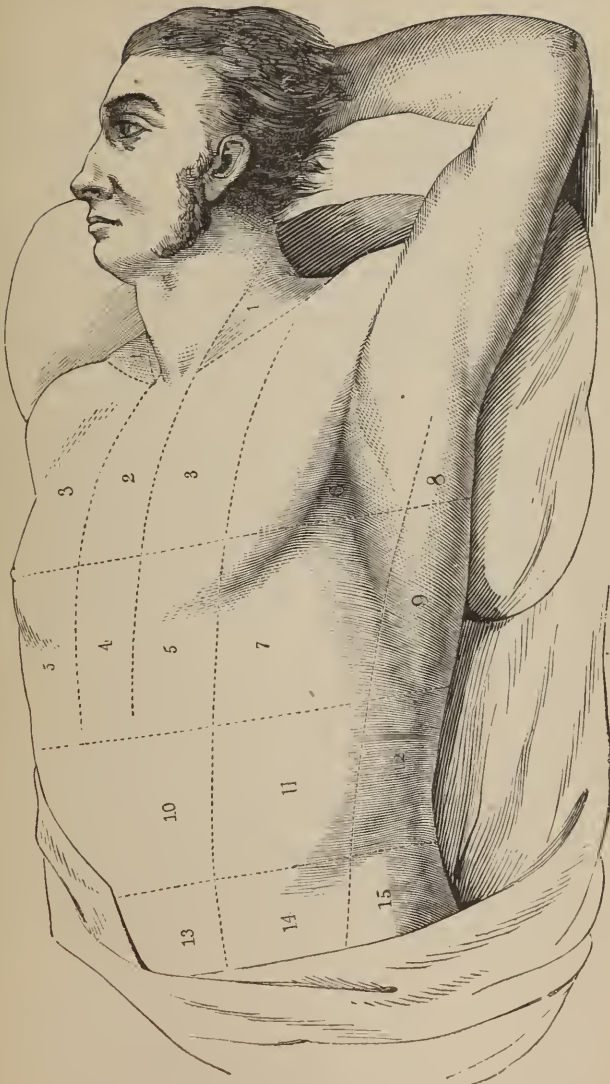
The phosphates and hypophosphites of calcium, etc., have been sufficiently tried to prove their inferiority to cod-liver oil.

Chlorate of potassium has also entirely failed under fair trial. Glycerin will not take the place of cod-liver oil; nor has any other oil been shown to be capable of doing so.

Iron, especially the iodide and the tincture of the chloride, are

[1] The mode of preparation of beef-tea is not unimportant. I prefer the following: Cut up a pound of good lean beef into small pieces, pour upon it a pint of cold water, and let it stand two hours beside the fire. Then boil it half an hour. Take off all the scum and oil drops, carefully; but *do not filter or strain it.* It should have a rich brown color; and, with salt, is agreeable to the taste.

Fig. 307.



frequently suitable; and so may be quinine, nux vomica, or the simple bitter tonics. But the patient must not be worried and disgusted with much medicine; whatever depresses appetite is likely to do more harm than good.

For this reason, *expectorants* require discretion in their use. Those of a nauseant kind must be very sparingly prescribed in phthisis. The syrup or fluid extract of wild cherry is one of the most suitable. Squills will answer when loosening effect is particularly required. Ipecac. and tartar emetic are too depressing to the stomach for the consumptive. Sometimes, at a late stage, carbonate of ammonium will not be too stimulant.

Anodynes and calmatives are almost always wanted as the case advances, to soothe the wearisome cough, and to give rest at night. Lactucarium, hyoscyamus, hydrate of chloral, and finally opium, or morphia, in some form, will be important sources of comfort to the patient, and may economize his strength.

The colliquative sweats seldom demand treatment, they being the *result* rather than the cause of debility. Ablution with brandy or whisky and alum may be practised if they are very excessive. Diarrhœa may require to be held in check, by simple astringents with opiates.

If pleurisy or peritonitis supervene as a complication, the local inflammation must be treated in view of the general condition. Depletion is out of the question at an advanced stage. Dry cups, blisters, and opium are all that we can use in the treatment. For the variable pains in the chest in the course of the disease, mild or moderate counter-irritation, by warming or belladonna plasters, tincture of iodine, or croton oil may be used.

Inhalation has often been tried in phthisis. Not enumerating agents which have summarily failed, the best hope attaches, in this way, to careful inhalation of the vapor of creasote or of carbolic acid.

Dr. W. Pepper has lately (1874) experimented, with somewhat encouraging results, with the injection of solution of iodine into *vomicæ*, by means of Dieulafoy's aspirator.

Change of climate is often proposed for the benefit of the consumptive. In an early, or middle, or even a stationary advanced stage, it may be of important advantage. When to forbid, or advise it, may be a very delicate question. More will depend upon the *rate* of progress than upon the period of the case.

In selecting a climate for the invalid, equability and dryness are, unless at a late stage, more important than warmth. That climate which will allow the patient the greatest number of days out of doors, will be the best. Central Florida in the winter, and Newport, R. I., in the summer, afford favorable conditions.

CHAPTER VIII.

AFFECTIONS OF THE ORGANS OF CIRCULATION.

Pericarditis.

DEFINITION.—Inflammation of the covering membrane of the heart.

VARIETIES.—Simple or idiopathic, and rheumatic pericarditis. The latter is very much the more common.

SYMPTOMS.—Fever; pain (occasionally absent) at and radiating from the heart; tenderness on pressure in the cardiac region; accelerated, irregular, or oppressed, rapid and feeble pulse; anxiety or delirium; nausea and vomiting in some cases; short hacking cough; towards the end, coldness and pallor or lividity, œdema of the face and extremities, loss of pulse.

STAGES.—1st. Acute inflammation; 2d. Adhesion; 3d. Effusion.

PHYSICAL SIGNS.—Before adhesion or effusion, usually, exaggeration of the heart's impulse. Then, pericardial *friction-sounds* (to and fro); the vibration of which is sometimes felt by the hand. After effusion, dulness on percussion, with muffling of the heart's sounds to the ear on auscultation. The friction-sounds disappear during this period, sometimes to return as the effusion is absorbed.

DIAGNOSIS.—From *endocarditis* and from *pleurisy* it is sometimes not easy to distinguish pericarditis. The symptoms of the latter and those of endocarditis are the same; and the *friction-sounds* occur in both. The heart's impulse is more apt to be sustained in strength in endocarditis; and, in the latter, no dulness on percussion occurs, nor are the heart-sounds muffled at any stage; while valvular mumurs follow endo- and not pericarditis.

Friction-sounds which are outside of the heart (pericardial) have a *nearer* character to the ear than endocardial sounds; they are more narrowly *limited*, not passing along the vessels; they do not keep exact time with the cardiac sounds, and may vary from day to day; and sometimes the vibration may be felt externally.

Pleurisy causes friction sounds, and afterwards dulness on percussion. But the former sounds are more diffused, are generally *single*, not "to and fro" or double; and the dulness extends further over and around the side. Latent pericarditis may possibly, from some symptoms, be taken for inflammation of the brain or of the stomach. Physical exploration should prevent such errors.

PROGNOSIS.—There is great danger to life in pericarditis; and its course is sometimes terminated by death in a few days. In other cases resolution may take place promptly; but more often the heart is clogged for a considerable time (weeks or months) with effusion, or a more protracted interference occurs from adhesion of

the pericardial surfaces. This latter is sometimes shown by a dimpling, or sinking in, with each beat of the heart, of the intercostal spaces above and below it.

Causation.—The *materies morbi* of rheumatic fever is far the most common cause of pericardial inflammation, as it is of endocarditis also. Gout is accused of the same thing; but with much less frequency, or, indeed, clearness of proof. Bright's disease of the kidney is occasionally associated with it.

Treatment.—In some cases, where fever is high and pain intense, leeches over the cardiac region may be used. A brisk saline cathartic, as Epsom or Rochelle salts, or citrate of magnesium, should commence the medication. Calomel, trusted still by some and abused by others, may be confined to open sthenic cases, in previously good constitutions. In such, give half a grain of calomel, with half a grain to a grain of opium, thrice daily for three or four days.

Where the rheumatic diathesis is marked, *alkalies* will be indicated. Carbonate or bicarbonate of potassium, or bicarbonate of sodium may be given, in scruple or half scruple doses, with as much of Rochelle salts, three or four times a day. A blister over the heart, as the fever lowers, will often have a very good effect. If effusion occur, blistering may be repeated.

Should no opiate be given through the day, Dover's powder or morphia may be prescribed at night.

For the stage of effusion, or "chronic pericarditis," the usual treatment consists of diuretics, as squills, juniper, sp. æth. nit. etc., varied and continued until absorption occurs. Tonics will often much promote the same end.

A *rapidly depressing* case of pericarditis, with cold, blue skin, and feeble, irregular pulse, will require, instead of the above, a supporting or stimulating treatment from the first; with dry cups and blisters instead of local or general bleeding; and quinine, ammonia, and whisky, instead of sudorifics or laxatives.

Myocarditis is inflammation of the muscular substance of the heart. It can hardly be said to have other than a nominal existence.

Endocarditis.

Definition.—Inflammation of the lining membrane of the heart.

Symptoms and Physical Signs; Diagnosis; Treatment.—These have been sufficiently stated in the account just given of pericarditis, and need not be repeated. Like that disease, it is most often of rheumatic origin; but may occur in Bright's disease or in pyæmia.

Valvular derangement and its signs give great interest to endocarditis and its resulting changes. Mostly it is the left side of the heart that is chiefly affected. The simplest and most common sign of this is a blowing sound, heard on auscultation. But a bellows murmur is heard also in cases of anæmia, and a blowing sound occurs not rarely in fevers; or it may belong to an organic heart-affection of long standing. This last fact should be ascertained by the history of the patient, as well as by the aid of symptoms; but the *old* murmur is generally rougher and more fixed in

its seat. It is *possible*, though very *rare*, for endocardial inflammation to be located so far from the valves as to cause no blowing sound.

Clots sometimes form in the heart in endocarditis (as well as in some other diseases attended by prostration), obstructing the circulation, even to a fatal extent. Although most clots are *postmortem* in origin, there is no doubt that sometimes firm fibrinous masses do occlude the valves for some time before death. The symptoms produced are, blueness and coldness of the skin, indistinctness of the heart-sounds, feebleness and irregularity of the pulse, nausea and vomiting, anxiety of expression, and fainting.

Much more often, vegetations or fibrinous deposits of exudation on the valves of the heart are carried in fragments therefrom by the blood into the arteries. Being arrested, as in a vessel of the brain, or a limb, etc., the condition of obstruction designated as *embolism* results; which receives attention in another part of this book. *Old* valvular vegetations, as well as the recent ones of endocarditis, may give rise to emboli; which, also, arise from coagulation in a vein, or *thrombosis*.

Endocarditis produces valvular derangement in the *mitral* valve most frequently in the young; in the old (from this cause as well as from degeneration), disease is rather more common in the aortic valve. The forms of disorder, indicated by murmurs, occur in the following order of frequency: 1st. Aortic obstructive; 2d. Mitral regurgitant; 3d. Aortic regurgitant; 4th. Aortic obstructive and mitral regurgitant together.

Enlargement of the heart, either with muscular thickening (*hypertrophy*) or with attenuation (*dilatation*) is a common consequence of endocarditis with valvular lesion. In every case the important question is, less the state of the particular valves, than ✓ the amount of interference with the functional action of the heart. In young persons, remarkable recoveries sometimes take place from very considerable lesion of the valves. In other instances, *adaptation* of the heart itself, and of the general system, by degrees, is effected, so that quite good health, and even capacity for exercise, may be attained, while the physical signs of the local organic change remain. Sudden death is less common in heart-disease than is popularly supposed. Some persons having it have lived twenty or thirty years. Dr. Black has shown the great importance of *breathing pure air* to persons who have symptoms of heart-disease after middle life.

Valvular Disease.

The valves of the heart may be impaired either by inflammation or by degeneration (*e. g.*, calcareous deposit or "ossification"). The latter, degenerative valvular changes, occur gradually; and mostly late in life. Either form of valve-disease, or at least of valvular alteration, is generally permanent; the *degenerative* form almost invariably so.

Changes may occur, by simple thickening, or by deposits of fibroid, fatty, or calcareous material; or by atrophy, contraction, adhesion, or ulceration of the valves; or gouty deposits, of urates and carbonates of sodium and calcium. The valve (mitral or aortic pri-

marily, or tricuspid or pulmonary secondarily) may be thus rendered incapable either of perfect closure, or of full opening; in most instances at least, a permanently half-open state results.

A considerable variety of pathological conditions may exist in organic disease of the heart; while the number of cases in which an exact and unequivocal diagnosis can be made, is comparatively small. We must not confine attention at all to the physical signs alone, but compare also with these the pulse, the force of the heart, other general symptoms, and the entire history of the case.

Certainty can hardly ever be obtained, unless it be (Stokes) in the diagnosis of one of the following three conditions:—

1. Uncomplicated disease of the mitral valve. Signs of this are—a permanent murmur, with the first sound, loudest towards the apex and left side, and not heard over the aorta; the second sound natural. The heart's action natural; the impulse not excited, the pulse natural.

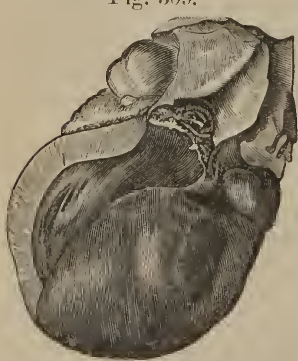
Fig. 308.

FIBROID THICKENING OF THE MITRAL VALVE.

2. Disease of the aortic valves, with permanent openness. With this, there is no murmur with the first sound; the second sound is replaced by a double murmur, loudest at the base of the heart, and heard along the aorta. In an advanced stage of this condition, the arteries give to the finger, or even to the eye, an impression of *bounding* pulsation; with a *jerking*, or abruptly ending pulse at the wrist.

3. Disease of the aortic valve, without permanent openness. Here, the action of the heart is slow and feeble, generally regular, or only occasionally intermitting. A murmur is heard with the first sound, the second sound being healthy; but a murmur may be heard with the second sound, in the aorta and carotids.

Fig. 309.



AORTIC VALVE WITH CALCAREOUS DEPOSIT.

It must be noticed that in *anæmia*, without heart-disease, a bellows murmur is often heard, extending into the arteries. Chiefly by the concurrent signs and symptoms is this to be distinguished from organic disease of the heart. Anæmic murmurs are more variable, and are not much increased by moderate exercise.

When the aortic valvular orifice is greatly *contracted*, the pulse at the wrist may become very feeble, almost absent; while the heart's impulse is strong.

Advanced mitral or aortic disease is accompanied usually by derangement, sympathetic or obstructive, of the lungs, liver, and other organs; with hæmoptysis, anasarca, cyanosis, irregularity of the pulse, syncope, etc. *Pulsation of the jugular veins* indicates mostly secondary disorder upon the *right* side of the heart, with regurgitation into the venæ cavæ. *Pseudo-apoplectic syncope* may occur in permanent patency of the mitral valve; or in fatty degeneration of the heart, with or without valvular disease.

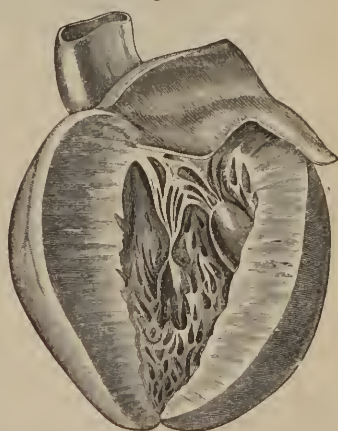
Dilatation of the Heart.

Uncomplicated dilatation of the whole heart, or of either pair of corresponding cavities, or of any one cavity, is very uncommon. *Complicated* dilatation is frequent. It may depend—1, on a debilitated state of the cardiac muscle; 2, on valvular disease; 3, on obstruction beginning in organs remote from the heart.

The commonest form of dilatation makes part of a triple affection, in which the *heart*, *lungs*, and *liver* are together involved. All this may come, in the first place, from a cachexia, such as gout, or scurvy, or from simple anæmia. Exacerbations in the disorder may occur; as, of pulmonary congestion, enlargement of the liver, cardiac asthma, bronchitis, or dropsy. The prognosis cannot be very favorable in such a case; and only palliative, or recuperative, treatment avails, along with hygienic management, to economize the powers of nature.

Dilatation of the heart is indicated, upon physical exploration, when, with extended impulse of the heart, we have dulness on percussion beyond the usual limits. If *true hypertrophy*, or muscular thickening, be present, the impulse is very *forcible* as well as extended. The heart-sounds are apt to be *clear*, though not loud, in *attenuated* dilatation; rather loud, but dull toned, in enlargement with thickening of the walls. But these differences are hardly to be relied upon.

Fig. 310.



Hypertrophy of Left Ventricle of the Heart.

Hypertrophy of the muscular tissue of the heart is most often induced by valvular obstruction or regurgitation, compelling unusual and continued efforts to sustain the circulation.

Sometimes, however, it is more truly idiopathic; following causes of overaction of a heart otherwise sound. Thus,

violent exercise, self-abuse, coffee, alcohol, tobacco, etc., are, with good reason in predisposed cases, accused of producing it.

In the TREATMENT of simple hypertrophy, avoidance of such exciting causes, and particularly of violent exercise, alcohol, and venery, is the main principle. Robust or plethoric patients may bear and be benefited by occasional leeching or cupping over the

Fig. 311.

heart. *Acetate of lead* as an astringent cardiac sedative, is recommended by some, and is worthy of trial (one grain thrice daily), with care to avoid saturnine poisoning.

Digitalis was formerly relied upon as a reducer of cardiac action. Lately the question has been opened widely, whether it does at all tend directly to lower the heart's action; or whether it is not, instead, a *tonic* to the heart (probably through ganglionic influence), lessening rapidity of action only when that depends on debility. The time has hardly come to pronounce finally upon this question. Evidence has been given to encourage us to use digitalis unhesitatingly where abnormal rapidity of the heart's action exists in conditions of debility; and to expect more from *veratrum viride* as a sedative and palliative, in *violent* acceleration of the pulse, as in muscular hypertrophy, and in some forms of palpitation.

Fatty Degeneration of the Heart.

DEFINITION.—Substitution of fatty substance for the muscular tissue of the heart, to such an extent as to interfere with its normal action.

SYMPTOMS AND COURSE.—Though no doubt almost always gradual in its progress, this affection in many instances fails to make itself known by symptoms until a late period ; sometimes even till the moment of death. Usually, feebleness and irregularity of the pulse and heart's impulse are observed ; with exhaustion and dyspnœa upon exertion. The pulse is slow when at rest ; sometimes only thirty in the minute, although the heart beats fifty or sixty in the same time. Attacks of apoplectic syncope or syncopal apoplexy may occur ; at first most like syncope, after repetition becoming more apoplectic. These are distinguished from true apoplexy by the feebleness of the pulse, coldness of the skin, sighing respiration, and the slightness or absence of paralytic symptoms, notwithstanding several repetitions of the attack. They are made worse by depletion or reduction of the system ; and may be relieved or warded off by timely stimulation ; the recumbent posture is most favorable in them. The first attack of this kind may, however, prove fatal.

PHYSICAL SIGNS.—Fatty degeneration is often complicated by the presence of other structural changes of the heart. By itself, it is with difficulty diagnosticated by physical exploration. The heart's impulse is feeble and slow, often irregular, and the sounds weak. A bellows murmur is frequently heard with one or both sounds.

MORBID ANATOMY.—True fatty degeneration must be distinguished from fatty *accumulation* about the heart ; which may impede its action, but is much less dangerous. In true interstitial degeneration, the heart is, in part or throughout, flabby and pale or yellowish, though it may be more bulky than usual. Minutely examined, the muscular fibrils are found to have lost their transverse striæ, and to have resolved themselves, more or less, into streaks of oil-dots or opaque granules.

Fig. 312.

RUPTURE OF THE HEART.

Death, sometimes, is shown to have resulted from rupture of the heart. In other instances that organ has, under some exertion or excitement, become exhausted and failed to act sufficiently to keep up the circulation.

PROGNOSIS.—Recovery is not to be expected in cases of fatty degeneration ; although life may be prolonged to old age. Much will depend upon circumstances of living, and care to avoid disturbing agencies.

CAUSATION.—In early life this affection is uncommon ; its most frequent cause is, then, pericardial

or endocardial inflammation. Most cases are met with after fifty years of age. It then occurs as one of the local manifestations of waning vital energy; but it may be promoted by any or all exhausting or depressing causes. No special or peculiar line of causation can be pointed out.

TREATMENT.—This can be only *conservative*, not curative. Tonics, particularly iron, with generous diet, sea or mountain air, change of scene, and avoidance of anxiety and exertion, may do much to retard the degenerative process. Violent effort or emotional excitement may be suddenly fatal. Tranquil occupation only should be selected, and all rapid exercise, and even straining at stool, ought to be avoided.

Modes of Sudden Death in Heart Disease.

We may briefly enumerate these as, 1. Arrest of the heart's action from debility of the muscular walls; 2. Spasm of the ventricles; 3. Extreme obstruction, or regurgitation; 4. Rupture; 5. Heart clot. Indirectly, cerebral or pulmonary apoplexy.

Angina Pectoris.

DEFINITION.—An irregularly paroxysmal disorder, characterized by sudden attacks of severe pain, extending from the heart along the left arm, with a sense of stricture in the chest, prostration, and alarm.

PATHOLOGY AND CAUSATION.—This appears to be a *symptomatic* affection; connected in most, if not in all cases, with organic disease of the heart; especially ossification of the coronary arteries. Gout predisposes to or excites it, but probably not in the absence of heart-lesion. It occurs generally in old people; most often in men.

PROGNOSIS AND DURATION.—The attack may last from a few minutes to an hour, or even a day. Commonly it is short, going off with perspiration or copious urination. A first attack may be fatal. Returns occur at variable intervals—days, weeks, or months; each one generally sooner and more violent, till one of them ends life.

TREATMENT.—Stimulants and anodynes are indicated during the attack. Best will be Hoffmann's anodyne, hydrate of chloral, laudanum, Warner's cordial, or whisky, in moderate doses, repeated in a short time if necessary; with mustard plasters over the chest and between the shoulders, and the warm foot-bath. Where gout is present, colchicum and alkalies may be important.

Thyro-Cardiac Disorder.

SYNONYM.—*Ex-ophthalmic Goitre.* Basedow's or Graves' Disease.

DEFINITION.—Enlargement of the thyroid gland in the neck with over-action of the heart and cervical vessels, and prominence of the eyeballs.

NATURE.—This uncommon affection is considered by Dr. Stokes to consist in a more or less permanent functional excitement of the heart; which may produce finally dilatation and hypertrophy, with dilatation also of the jugular veins, and an

aneurismal condition of the thyroid gland. Although considerable disturbance and prostration of the system must attend such a state of things, yet it has been repeatedly recovered from. The *cause* of the affection has not been made out.

Treatment.—Tranquillization of the heart is the main indication. *Veratrum viride*, in doses not at all nauseating (two or three drops of the tincture every three or four hours), may be persevered in, while watching its effects. Other treatment must depend upon the general condition of each patient. Of course violent exercise and mental excitement must be avoided.

Palpitation.

All excessive or consciously disturbed action of the heart is commonly thus designated. Over-action, in particular, may have either of the following origins :—

1. *Nervous*, or hysterical; 2. *Dyspeptic;* 3. *Rheumatic*, or *gouty;* 4. *Hypertrophic.*

All of the above forms of merely functional disturbance of the heart, and especially the purely nervous, may be known from *hypertrophic* over-action, or the conscious impulse of *dilatation* of the heart, by the fact that they are not increased by moderate exercise; are often, indeed, much diminished thereby. When the heart is enlarged, especially with valvular change, active movement causes distress and dyspnœa, with great acceleration of the cardiac movement. In palpitation of all kinds, during the attack, it is generally not possible to lie with ease upon the left side; and orthopnœa may occasionally occur, without organic disease.

The treatment of palpitation must vary according to its cause. If nervous, invigoration of the system and enrichment of the blood are most probably needed, by iron and other tonics, and regimen. Dyspepsia will require appropriate treatment; as a part of which exercise in the open air will not be counter-indicated at all by sympathetic palpitation.

Aneurism of Thoracic Aorta.

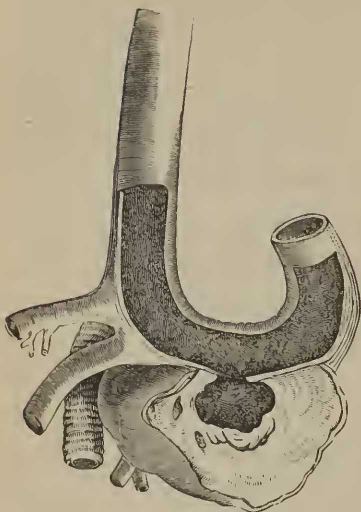
A *bulging* in the front of the chest, in which pulsation is felt, not continuous or identical with that of the heart, and over which resonance upon percussion is dull—is probably an aneurismal tumor. If a thrill is also perceptible in it, with or without a murmur on auscultation, we may be still more confident in the diagnosis; and when the signs of pressure upon the air-tubes, œsophagus, sympathetic or recurrent laryngeal nerve, or thoracic duct occur, it is nearly certain.

Murmur may, however, be absent; so may thrill; the bulging may be slight, and the percussion resonance little altered. The sign of most consequence is, the existence of *two* points of pulsation in the chest, the cardiac and the aneurismal; the latter coinciding almost with the diastole of the heart.

The signs of pressure are, chiefly, pain, cough, dyspnœa, loss of voice, difficulty of swallowing; and emaciation from obstruction of the thoracic duct.

Cancerous or other tumors may produce all these latter signs; but such tumors do not pulsate. In *empyema* the beat of the

Fig. 313.



ANEURISM OF THE AORTA.

heart sometimes impels the fluid so as to throb rather widely; but this is still a *single* cardiac impulse. Occasionally a consolidated lung, in phthisis, may vibrate forcibly, with the pulmonary artery; but other signs then make clear the disease.

The course of aortic aneurism is usually very gradual—often lasting for a number of years. Death occurs—1, from sudden rupture and copious hemorrhage; 2, from slighter rupture and slow leakage; 3, from slow exhaustion by pressure, interfering with respiration, deglutition, etc.

The CAUSATION of thoracic aneurism is obscure. It occurs nearly always in rather elderly people, in whom the process of degeneration of the vessels has commenced; but now and then it is met with before middle life.

Abdominal Aortic Aneurism.

Of this, the SIGNS and SYMPTOMS are—deep-seated severe pain (occasionally intermitting) in the back and abdomen, increased by certain movements; unaccompanied by fever, but resisting all treatment; later, muscular spasms of the lower limbs, displacement of the liver, and the manifestation of a pulsating abdominal tumor, felt upon palpation, over which there is dulness of resonance upon percussion. The higher up the aneurism, the more severe are the pains and other symptoms of disturbance.

Aneurism of the aorta may, without careful examination, be confounded with aortic *pulsation* without tumor (common in dyspepsia, etc.), or with neuralgia, rheumatism of the bowels, colic, worms, disease of the liver, caries of the spine, psoas abscess, or cancer. Only the discovery of a distinctly *pulsating tumor* (not a tumor moved by subjacent pulsation) can establish the presence of aneurismal disease.

The TREATMENT of thoracic or abdominal aortic aneurism is almost null. *Hygienic measures* may retard decline, and careful self-management may avert a sudden catastrophe. Exertion and excitement must, of course, be prohibited. Prolonged *pressure on the aorta* has sometimes effected the cure of abdominal aneurism.

CHAPTER IX.

AFFECTIONS OF THE BRAIN AND NERVOUS SYSTEM.

Inflammation of the Brain.

SYNONYMS.—*Encephalitis*, *Phrenitis*, *Meningitis*, *Cerebritis*. The last two are not, of course, technically identical; but they are not clinically separable. Inflammation of the membranes derives its importance from the implication of the brain.

VARIETIES.—*Simple* and *scrofulous* encephalitis or meningo-cerebritis.

Simple Meningo-Cerebritis (meningitis).

SYMPTOMS.—Intense headache, redness of face and eyes, an excited look, dizziness, roaring in the ears, extreme sensitiveness to light and sound, restlessness, wakefulness, wild delirium. Vomiting is common; the bowels are usually costive. Late in the attack in adults, at any period in children, convulsions may occur. Rigidity of the muscles is frequent in bad cases; paralysis often follows convulsions.

STAGES.—These are generally described as three. 1st. That of active congestion and inflammation; with hot, hard, *rapid*, full, regular pulse, morbid sensitiveness to light and sound, headache and delirium. 2d. That of commencing effusion and cerebral oppression; with more moderate heat of the surface, stupor, and *slow* or irregular pulse. 3d. That of cerebral disability or disorganization; with unconsciousness, convulsions, muscular rigidity or paralysis, and *rapid, feeble pulse.*

MORBID ANATOMY.—Except in *traumatic* cases, the dura mater rarely takes part in the lesions of encephalitis. Rather minute hyperæmic injection is found here and there in the arachnoid membrane; sometimes opacity and thickening occur, with adhesions. In the pia mater, generally with considerable increase of redness, serum has been effused; or even pus. The pia mater adheres firmly to the brain. The ventricles contain more serum than usual; sometimes several ounces. In some cases it is turbid, flocculent, or purulent. The brain itself is most frequently affected, with redness in the convolutions, and dots of blood in the medullary portion; also, with softening in the gray or white substance, or in both.

DIAGNOSIS.—The distinctions between simple and tuberculous or scrofulous meningitis or encephalitis will be considered presently. Typhoid fever, delirium tremens, and acute mania may be confounded with or mistaken for inflammation of the brain.

Typhoid fever does not usually have vomiting, long-continued headache, or morbid sensibility to light among its symptoms;

while tympanites, diarrhœa, bronchitic cough, etc., make it known. In delirium tremens, the origin of the affection in alcoholic excess, the mostly horrible illusions, tremor and insomnia, *without headache*, are characteristic. Acute mania is almost or quite without fever; often without headache; and the muscular strength is little impaired; vomiting, also, is absent.

Subacute or *chronic* encephalitis, now and then met with, presents greater difficulty in distinguishing it from mania. Indeed, the best authorities in psychopathology (study of mental diseases) state that cerebral hyperæmia and inflammation bear a not unimportant part in the pathology of insanity. (See *Winslow on the Brain and Mind.*)

Children afford not unfrequent instances of another question in diagnosis—how far *symptoms* affecting the brain may or may not depend upon the *stomach* for their causation. "Gastric fever" and "infantile remittent" are phrases applied often to attacks occurring in childhood or infancy; in which, with indigestion and vomiting, there is delirium, stupor, or apathy, with or without convulsions. In such cases, the heat of head and fulness of the carotid and temporal arteries are less, the gastric disorder, fur of tongue, etc., greater, than in cerebral inflammation. *Cholera infantum* is often attended by brain symptoms; but its other features, the time of year, and locality (in a large city almost always) are distinctive.

Prognosis.—Simple encephalitis, under good treatment, is not always fatal; but a majority of cases end in death.

Causation.—Between fifteen and forty-five is the age most subject to this disease. Males are more liable than females to it. Hot climates predispose to it; and so does intemperate living. Exciting causes are, blows or falls upon the head, exposure to the sun, violent or prolonged mental excitement, erysipelas of the head, scarlet fever, metastasis of rheumatic or gouty inflammation, repulsion of eruptions upon the skin, suppression of accustomed discharges. Extension of inflammation from the ear (otitis) to the brain is a possibility, important not to be overlooked.

Treatment.—No disease is more likely to be benefited in vigorous subjects by early venesection than acute inflammation of the brain. But its usefulness depends upon its being early; and it should seldom be repeated. As in other cases of inflammatory disease, many physicians now omit it altogether. Leeching or cupping may follow it or take its place.

Purging actively is important; by sulphate or citrate of magnesium, or, if dosing be difficult from delirium, croton oil, or elaterium. After one free purging, *moderate* catharsis may be, if necessary, repeated every two or three days; and the bowels should be kept open during the attack.

Cutting the hair very short, or, still better, shaving the whole head, will aid in giving relief, and will allow the effectual application of cold. Pounded ice, in a bladder or bag of India-rubber, will do if watched and changed in place often, to prevent too great an impression upon one part. Many prefer a linen cloth (as a cambric handkerchief) folded once, dipped in *ice water*, and laid over the head; it should be wet freshly *every few minutes*, or the good effect is almost lost. Merely wetting the head now and

then with cold water produces a *reaction*, not a *sedation*, which is required. If the feet be cold, they should be made warm by mustard foot-baths or sinapisms. In children, the prolonged warm bath may be useful.

The diet in the first part of the attack should be as light and unstimulating as possible. Oatmeal gruel, panada, rice, toast-water, may come first; then milk, chicken-water, mutton broth; later, beef-tea.

Blisters are serviceable after the intensity of the inflammatory excitement has begun to diminish. The best will be a blister *over the whole scalp*. It need not remain on many hours.

In a late stage, with secondary debility, concentrated liquid diet, with alcoholic stimulants, and even opium at night, may be required to support the flagging energies of the system.

Convalescence in the best cases may be slow. The faculties may remain feeble, and the brain morbidly excitable, for weeks or months; needing great care as to all mental impressions and efforts, lest a dangerous relapse occur, or chronic cerebral hyperæmia, perhaps insanity, follow.

Tubercular Meningitis.

Acute Hydrocephalus.—From two to fifteen years is the age most apt to yield examples of this fatal disease. *Premonitory* symptoms usually occur; dulness, pettishness, and languor; headache; disposition to put the head in the mother's lap, or to lie down; loss of appetite; vomiting; and costiveness. The child sleeps ill, with grinding of the teeth, or sudden starting with alarm. After four or five days, constant headache and anxiety of countenance, heat of head, sensitiveness to light, fever and drowsiness, alternated with moaning or occasional *screaming*, and delirium at night, mark the case.

Advanced symptoms are, total stupor, strabismus, convulsions, and paralysis. The *pulse* goes through similar changes to those of simple encephalitis; first febrile acceleration, then irregularity and slowness, lastly the rapidity of moribund prostration. The attack terminates on the average in between two and three weeks.

PROGNOSIS is always unfavorable in this disorder.

MORBID ANATOMY.—Since Papavoine, Rufz, and Gerhard showed the existence of a relation between tuberculosis and "acute hydrocephalus," autopsic inquiry has proved fully, 1st, that tubercle-like granulations, with opacity and thickening of the arachnoid at the base of the brain, adhesion between the hemispheres, and serous effusion, characterize a number of the cases; 2dly, that all of these lesions may be found without any tubercle whatever; and, 3dly, that the amount of such deposits in *most* cases is not sufficient to modify greatly the course of the local disease, at least in such a manner as tubercle acts elsewhere.

We conclude, hence, that it is rather the *diathesis* than the *deposits* that make the disease to differ, as in progress and prognosis it clearly does, from simply meningitis or encephalitis.

TREATMENT.—Purge moderately, not exhaustively; blister the head or back of the neck; apply cold with care, and allow liquid nourishment, such as milk and beef-tea, mutton or chicken broth,

etc., from an early stage. Iodide of potassium is recommended by some practitioners.

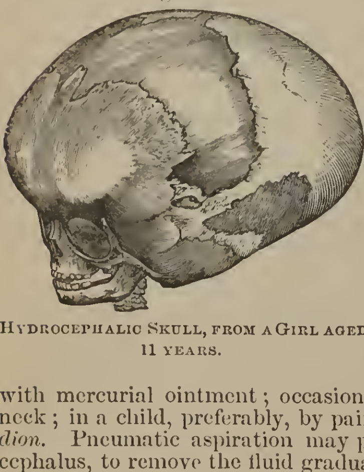
Hydrocephalus.

DEFINITION.—Water in the head; dropsy of the brain. This is almost always an affection of early life. Sometimes it is congenital. It is mostly a passive dropsical effusion; certain cases show signs of a chronic or subacute inflammatory condition of the arachnoid membrane.

SYMPTOMS.—Languor, strabismus, convulsions, loss of appetite, increase in the size of the head. This last may be enormous; the fontanels expanding, and, in a slow case, the bones growing excessively large. The mental faculties nearly always grow dull. Bodily emaciation and debility attend.

Although cases are known and recorded in which hydrocephalic persons lived for more than twenty years, the general rule is that they die in a few months; either from cerebro-spinal disability or atrophy, or from some intercurrent disease not endurable by the impaired vital energies of the system.

Fig. 314.



HYDROCEPHALIC SKULL, FROM A GIRL AGED 11 YEARS.

TREATMENT.—Small as is the encouragement given by experience in this affection, it is certainly justifiably to *try* measures not out of place in themselves. Such are, moderate purging, every few days, or once a week, sustaining the strength by nourishing food, and, if it be borne, cod-liver oil; diuretics; shaving the head and rubbing it nightly with mercurial ointment; occasionally blistering the back of the neck; in a child, preferably, by painting it with *cantharidal collodion*. Pneumatic aspiration may perhaps prove useful in hydrocephalus, to remove the fluid gradually and safely.

Softening of the Brain.

Pathologists generally recognize two forms of this: 1. Acute red *inflammatory* softening; and 2. Slow, white, *atrophic* softening or degeneration of the brain-substance. Both receive the name of *ramollissement*.

The former of these is farther definable as a local cerebritis; whose symptoms are not nearly always separable, clinically, from those of meningitis or encephalitis, already described. Cadaveric inspection shows not only hyperæmic redness and softening, but, sometimes, abscess, or even gangrene of the brain. This last (gangrene) is probably always the result of injuries. *Induration* of the brain may also follow (especially traumatic) inflammation of the

brain. The cerebrum is more often affected with red softening than the cerebellum.

Abscess of the brain is in a certain number of cases latent for a considerable time. Sudden headache is apt to be the earliest symptom. This is attended by feverishness, vomiting, difficulty of speech, numbness, convulsions, paralysis, and coma. *Otitis* and *pyæmia* are said to be, after injuries, the most frequent direct causes of it.

DIAGNOSIS.—*Acute Red Softening.*—The occurrence of imperfect coma, with rigidity of the muscles of the extremities, or of paralysis without loss of consciousness, will make probable this lesion. Most cases die within two weeks; some within two or three days.

White atrophic softening or degeneration of the brain may take place as a result of old age, or from intense mental labor or excitement, from intemperance, or from *embolism;* that is, obstruction of an artery within the brain by a fibrinous clot carried from some other part. Its approach and progress are more slow and insidious than those of acute inflammatory ramollissement. Neuralgic pains in the limbs, followed by numbness and paralysis; general debility, and dulness of the senses, gradually increasing to blindness, loss of hearing, etc., and a corresponding decline of the mental powers; these are the usual symptoms, which may be extended over a period of many months. Death is sure to be the final result.

TREATMENT.—If *inflammatory* red softening can be diagnosticated at an early period, a similar treatment to that named for acute meningo-encephalitis may be advised. Local depletion, at least, followed by counter-irritation by blisters, may be resorted to in a case which appears to be such; the more freely, because apoplexy, which most nearly simulates it, presents very similar practical indications.

Chronic atrophic white softening is not amenable to any such measures; nor, indeed, to any active remedial treatment. Prevention, by the avoidance of its causes, and palliation or economy of the waning powers of the system, are alone possible. The management necessary under such indications must vary with every case.

Inflammation of the Spinal Marrow.

CLINICAL SYNONYMS.—*Myelitis, Spinal Meningitis.* The symptoms of this uncommon affection are, constant and severe pain in the back, increased by motion; spasmodic contractions or rigidity of the muscles followed by paralysis, fever, constipation of the bowels, and retention of urine. Authors state that in *myelitis proper*, as distinguished from *spinal arachnitis*, there is no pain nor muscular rigidity, but only paralysis of motion and sensation.

MORBID ANATOMY.—Diffuse redness and opacity of the arachnoid, swelling and infiltration of the pia mater, and effusion of serum, cammunicating freely with the cavity of the cranium, are generally found. Adhesions of the membranes from plastic lymph are less common; and still less so, though repeatedly recorded, is suppuration within the arachnoid. The dura mater is occasionally affected with inflammation, and even ulceration and gangrene,

commencing from without. The cord may be reddened from injection of its substance, and softened; more rarely indurated in parts.

TREATMENT.—Cupping or leeching along the spine, followed by a blister, and active purgation with saline cathartics, constitute the essential parts of the treatment of simple inflammation of the spinal cord or of its membranes. If the diagnosis be doubtful, the practice must be disproportionately less bold; this is, of course, a principle of very general application in therapeutics.

Epidemic cerebro-spinal meningitis will be considered hereafter, as *Cerebro-spinal fever.*

Apoplexy.

DEFINITION.—Sudden coma, produced neither by injury nor by poison.

VARIETIES.—Some terms once used have been shown to be without pathological justification; as *serous* apoplexy, *nervous* apoplexy. Good authority still sustains, however, the mention of two forms at least of genuine apoplectic seizure: *congestive* and *hemorrhagic.*

SYMPTOMS.—*Congestive Apoplexy.*—Premonitory symptoms often seen are, flushed appearance of the face and eyes, heat of head, throbbing of the carotids, distension of the temporal arteries and jugular veins; constipation, languor, dulness, drowsiness; dimness of sight, vertigo, headache. The attack is marked by sudden stupor; with slow and sometimes snoring respiration, full and slow pulse, dusky or turgid appearance of the face. The total loss of perception may be brief, its partial absence or deficiency continuing for some time. Slight convulsive movements are not uncommon. Paralysis of the muscles occurs only for a short time after the attack, if recovered from.

Hemorrhagic Apoplexy.—Generally no clear premonition is given, the attack being very sudden; a *stroke*, literally. Unconsciousness is complete, for some seconds, minutes, or hours. After this, general or local paralysis, most often hemiplegia, is left; the mental powers also, in many cases, being impaired at least temporarily. During the coma, the breathing is commonly stertorous, and the pulse slow, and somewhat full, the head hot, the face more or less dark or flushed. But the fulness of the bloodvessels and heat of the head are much less, as a rule, than in congestive apoplexy.

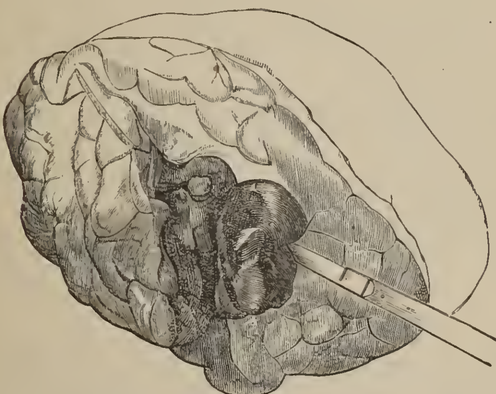
ANATOMY AND PATHOLOGY.—In the congestive form, excessive cerebral hyperæmia produces coma by pressure upon the brain; the extremest degree of which (vascular pressure) is met with in strangulation.

In hemorrhagic apoplexy, from the rupture of a degenerated artery, either in the substance of the cerebrum or cerebellum, in the ventricles, or under the arachnoid membrane, effusion of blood occurs, and a clot is formed. If this be small, it may be gradually absorbed; autopsic inspection sometimes shows the remains of such, where another hemorrhage has caused death. Fatty degeneration of the arteries of the brain has been repeatedly, but not

always, observed ; and miliary aneurisms of the cerebral arteries have been often noticed, by Charcot and others.

The age of the clot may be ascertained in part by the discovery, with the microscope, of *blood-crystals;* which are not found until after seventeen or eighteen days from effusion.

Fig. 315.



HEMORRHAGE INTO RIGHT LATERAL VENTRICLE AND RIGHT HEMISPHERE OF THE BRAIN.

DIAGNOSIS.—Apoplexy is to be distinguished from *uræmia*, *alcoholic intoxication* (dead drunkenness), *narcotic poisoning* (as from opium), *compression of the brain*, or *concussion*, from blows or falls, *asphyxia* (suffocation), *sunstroke*, *catalepsy*, *cerebral hysteria*, *acute softening of the brain*, and *spotted fever* or "cerebro-spinal meningitis ;" as well as from all forms of *syncope*. From uræmic coma it is only to be known by the history of the case, showing a renal origin for the symptoms, in partial or total suppression of the urine. Alcoholic intoxication is revealed by the odor of the breath, and the attendant circumstances. Similar aid exists sometimes in cases of narcotic poisoning ; in opiate narcotism, moreover, the pupil is *contracted;* in that from most other narcotics, it is as firmly *dilated*. Concussion and compression of the brain are generally suggested by the position of the body (if found without a history), and the external marks of injury. Asphyxia also is usually pointed out by the condition of things surrounding the patient.

In asphyxia, blueness of the lips, and embarrassment of respiration, with coldness of the surface, show the origin to be in the function of breathing. Sunstroke is attended by feebleness of the pulse, at least in the majority of cases ; in some, it *is*, identically, a congestive apoplexy. In catalepsy, there is rigidity of the muscles, with rapidity of the pulse, susceptibility of the pupil to light, brief duration and repeated recurrence of the attack, without any paralysis. Cerebral hysteria is rare, and occurs only in

females, whose previous disorders of the nervous system will aid in interpreting even coma as belonging to the same category. Acute red softening of the brain may be very difficult to distinguish from apoplexy. It is, however, seldom if ever so sudden in its invasion; there is more slobbering or flow of saliva, and watering of the eyes; and there is not the partial or entire restoration of the faculties which an attack of apoplexy, not fatal, allows so often. Spotted fever, or "cerebro-spinal meningitis," will be especially described, and its diagnosis considered, in another place.

Syncope, of any form or origin, is marked by *pallor*, *coldness*, and *loss of pulse*.

PROGNOSIS.—This is always alarming; most so when there is the most reason to believe that cerebral hemorrhage has occurred; and, therefore, especially in those advanced in life. In younger subjects, where stertor of breathing is absent, under proper treatment, congestive apoplexy may be entirely recovered from. So may a single attack of the hemorrhagic form, with a small clot only, and limited, transient paralysis. Each succeeding attack becomes more dangerous; a third is seldom survived. The *immediate* danger connected with an attack of apoplexy should not be considered over for ten days at least after the stroke itself. Very seldom, indeed, after a hemorrhagic attack, are the mental or bodily powers so good, for the rest of life, as before.

CAUSATION.—*Age* is the most constant promotive cause of apoplexy. Cases are on record, though of extreme rarity, in children; between thirty and fifty it is much more frequent; but after fifty it is one of the most common modes of death. Arterial degeneration is here the general occasion of the catastrophe; some mental excitement, or bodily shock or effort, as danger, or joy, or a few glasses of wine, or the stooping posture, or straining at stool, causing a rupture of the weak vessel, and fatal cerebral hemorrhage. Neither sex seems to be more liable to this disease than the other.

Full living, especially with alcoholic intemperance (even moderate) and indolent habits, predispose to it in a marked degree. So does excessive brain work. Florid, short-necked, big-bellied people are most exposed to it. Hypertrophy of the left ventricle of the heart is believed to promote it. After dinner and during sleep are the two most likely times for the attack to occur.

TREATMENT.—The younger the patient, and the more vigorous his antecedent health, the more probable is the existence of the congestive form; and, also, the better the prospect of recovery from hemorrhage within the cranium, if, only, the effects of pressure be averted at the time. If, then, in a person under fifty, not before of broken constitution, we find the head hot, face turgid and flushed, the arteries and veins of the neck and temples full, the pulse also strong, and the *heart's* impulse so (or the heart's action vigorous though the pulse at the wrist be oppressed) blood may be taken, carefully, from the arm, or by cups or leeches applied to the back of the neck.

Older or more doubtful cases may be treated tentatively, with cups alone, aided by mustard plasters to the legs, back, and epigastrium in turn; with laxative injections into the rectum during the attack, and saline purgatives afterwards. The head should

be kept raised, and cooled with wet cloths until its temperature become normal. If the hair be thick, it should be cut very short or shaved off entirely.

When, however, there is reason, as usually is the case in really *old* or *broken-down* patients, to believe that *structural degeneration*, arterial or that of ramollissement, is the source of the attack, loss of blood will be *out of place*. It may even, by exhausting the enfeebled system, hasten death. Such cases, if they survive the first apoplectic fit, require rather nourishing diet, and sometimes even tonics, to support strength, favor repair, and prolong life. Great delicacy of judgment, of course, is necessary in deciding in different cases between these apparently so opposite modes of treatment. The tendency of medical opinion, for the last ten or twenty years, has been towards the curtailment, to a great extent, of the use of the lancet in apoplexy.

Where a moderately plethoric condition is present, and the taking of blood, generally or locally, is not decided upon, purgation is safe and likely to be useful. Jalap, resina podophylli, or croton oil, in small doses, will have the advantage of convenient administration.

Aphasia.

Loss of speech may occur as one of the symptoms of disease of the brain, either functional and transient, or organic and irremovable. Such a loss of *language* is termed *aphasia*. Importance has been given to it lately by the observations of Trousseau and others, and resulting speculations (Dax, P. Broca) as to the seat of the faculty of speech. Not articulation, as in aphonia, but *expression* is, in this affection, wanting. The power to *write* words from memory, to convey meaning, is lost; but, in some cases, at least, they may be *copied* correctly. *Thinking without words* may go on in such instances; as Lordat recorded, after recovery, in his own case.

Hemiplegia of the right side has in a number of examples coincided with aphasia; and, several times, also, autopsy has shown softening or other lesion of the left anterior portion of the cerebrum. On the suggestion of these facts a hypothesis has been based, that the site of the faculty of language is in the third anterior frontal convolution of the left hemisphere of the cerebrum. This is a very *unphysiological* supposition, in view of the *symmetry* of the cerebro-spinal axis throughout; nor does this objection disappear even upon the conjecture that the "organ" upon the right side may exist always in an undeveloped state. Valvular lesion of the heart sometimes accompanies this disease.

Cases of aphasia are rare. There are no special measures of treatment for it pointed out as yet by experience.

Paralysis.

VARIETIES.—*According to the proximate cause:* 1. Cerebral palsy; 2. Spinal; 3. Reflex paralysis; 4. Toxæmic (*e. g.*, lead palsy); 5. Hysterical palsy. *According to the extent of the affection:* Facial or other local palsy; Hemiplegia; Paraplegia; Gene-

ral paralysis. *According to its nature:* Motor (acinesia), and Sensory paralysis (anæsthesia).

Facial Palsy.—This is an affection of the *portio dura* of the seventh pair of cephalic nerves, the motor nerve of the face. It occurs at any age, usually from rheumatoid inflammation of the sheath of the nerve at its escape from the cranium through the stylo-mastoid foramen. One side of the face is without change of expression; and the eye on that side is not closed (in severe cases) from the paralysis affecting the *orbicularis palpebræ* muscle. The tongue is not affected in the movements.

The facial motor nerve is not often involved in the much more serious cases of *cerebral* palsy. Absence of disturbance or of incompleteness of control over the tongue, while the power over the eyelid is partly or wholly lost, with the absence also of severe cerebral symptoms, will, especially in a young person, make the diagnosis easy as well as important. The PROGNOSIS is, generally, of recovery in a few days or weeks. The TREATMENT of this form of local palsy may be by repeated small blisters behind the ear; followed, when convalescence has begun, by some warm covering (cotton wadding, flannel, or silk) to protect the part from cold.

Other Local Palsies.—Pressure upon a nerve may cause its paralysis, generally temporary. A man has been known to have his hand rendered powerless for three weeks by sleeping all night with his arm bent under his head. Frictions, the endermic application of strychnia, and galvanism may be used in such a case. *Writer's cramp*, or scrivener's palsy, is the result of exhaustion of certain muscles from over-use. Its cure is rest.

Palsy of the optic nerve is designated as *amaurosis;* of the sense of hearing, *cophosis;* of taste, *ageustia;* of smell, *anosmia.* Except the first, however, these terms are not much used.

Hemiplegia.—Brain-lesion is most often the cause of this affection; either an apoplectic clot, a tumor, or softening. Spinal disease may, however, produce it; and some cases are, by writers upon the subject, referred to a peripheral or reflex origin. There may occur, also, sometimes transiently, *epileptic*, *choreic*, and *hysterical* hemiplegia. Owing to the decussation of the anterior pyramids of the medulla oblongata, lesion of one side of the brain produces motor paralysis of the other side. In spinal lesion the palsy is usually on the same side. Brown-Séquard, however, has shown decussation of the sensory nerves in the cord; and he explains the symptoms in some cases thereby.

SYMPTOMS.—Suddenly, almost always, but not always with loss of consciousness, the patient loses the power of motion, and more or less of sensation on one side. In *complete* cases, the parts involved are the arm and leg, the muscles of mastication (with the buccinator), and half of the tongue. In trying to protrude the tongue it is pushed out towards the affected side: in retracting it, the reverse happens; that is, it is drawn towards the sound side. The palsied cheek hangs; but the eye can be shut or opened at will. The third, fifth, and ninth nerves are especially apt to show implication by disturbance of the actions under their control; of the fifth, those of the muscles already mentioned, as well as of facial and lingual sensation; of the third, loss of power to lift the

eyelid, strabismus, and dilatation of the pupil; the ninth, one-sided movement of the tongue, affecting also the speech.

Hemiplegia may be attended either by rigidity or relaxation of the muscles; and the former may be early or late. Where there is decided relaxation in cerebral paralysis, it is probable that white softening, or atrophy from embolism of the brain, is the lesion, with or without a clot; where early rigidity is marked, an apoplectic clot may be inferred. Late rigidity is probably due to an atrophic state of the muscles; a "*rigor mortis in vita.*" Contradictory accounts are given by authorities as to the susceptibility to galvanic excitation of the muscles on the sound and on the *paralyzed* side. It is probable that the loss of excitability of the muscles is in proportion to their atrophy.

The PROGNOSIS in hemiplegia depends greatly on the ascertainment of its causation. If it follows an epileptic fit, or attack of chorea, or occurs in a hysterical subject, it may be of comparatively brief duration, ending in recovery. If an apoplectic attack precede it or if any lesion of the brain be inferred from the history of the case, the prospect is bad. Partial improvement may occur, not often entire restoration; and renewed attacks or "strokes" are likely to follow.

TREATMENT.—Essentially the same principles are applicable to this as have been mentioned in connection with apoplexy. The younger the patient, the more vigorous his or her previous health, and the fuller the circulation, the more appropriate may be the general or local abstraction of blood, to diminish pressure upon the brain. Where softening is apprehended, bleeding should be exceptional and cautious. Epileptic, choreic, and hysterical hemiplegia indicate little or no depletion as a rule. Rest, regulation of the bowels, and counter-irritation by dry cups to the upper part of the spine, and afterwards a blister; with frictions, as with brandy and red pepper, or whisky and hot water, or salt and spirits, to the affected limbs; these are measures of general utility. A seton in the back of the neck is sometimes recommended. As to strychnia, it is not safe where cerebral or spinal irritation is likely to exist, as near the commencement of most attacks. Even at a late stage it should be used with extreme caution, watching its effects. Precisely the same statement may, upon the best authority, be made as to electricity, in cerebral paralysis. In the *hysterical* form, if it last long, electricity may be applied locally, with safety and advantage. In any curable case, *passive exercise* of the weak limbs will be very useful.

Paraplegia.—This is paralysis of both the lower extremities. *Spinal* disease or injury is its source; with or without cerebral implication or complication. It may come suddenly or gradually; generally its beginning, at least, is sudden. *Reflex* paralysis, as described by several authors, is sometimes paraplegic.

SYMPTOMS.—In organic or spinal paraplegia, as well as in the reflex form, numbness in the feet and pain in the back are apt to be early signs. The power of motion is lessened or lost in the lower limbs. The muscles may be either relaxed or contracted. The lesion of the spinal marrow, if progressive, is productive finally, in many cases, of loss of power over the bladder and sphincter ani.

Bed-sores, with deep ulceration and sloughing, may occur in protracted cases.

TREATMENT.—When *myelitis* is believed to exist, at an early stage, local depletion to a moderate extent, in otherwise good subjects, may be advised. In any case, counter-irritation (not vesication, in a bedridden patient, unless he can lie well on either side), by repeated sinapisms, or stimulating liniments, will be proper.

While inflammation or active irritation of the spinal cord is made apparent by the symptoms (pain, cramps, muscular twitchings, or rigidity), strychnia is not suitable. After these have subsided, it may be given—not more at first than the thirtieth of a grain twice daily. If it produce jerking movements of the hands or feet, or nervous restlessness, or any marked uneasiness, it should be suspended. Electricity may be used, with similar caution, in a secondary or relatively late stage of paraplegia. Moderate (at first very gentle) shocks of the interrupted circuit are preferred.

Hysterical Paralysis.—In females this is among the many forms of functional disorder which that strange and not yet clearly defined disorder, hysteria, may produce. It is diagnosticated by the aid of the history of the patient. Dr. Todd stated that, in it, the affected limb (it is most often hemiplegic), in walking, is dragged after the other, as if a dead weight; while in cerebral hemiplegia the palsied leg and foot are brought round in a curve, the body being bent toward the sound side at the time.

TREATMENT.—Tonics, good nourishment, and change of air (in a word, analeptic management), are most needed in nearly all hysterical cases. For the paralysis itself, electricity has been found useful. Mild shocks for a few minutes twice a day may be given with the magneto-electric apparatus.

Reflex Paralysis.—Since Stanley's paper (1833), asserting the production of paralysis, sometimes, by disease of the kidney, a number of medical writers have added to the list of supposed cases of "paralysis without apparent lesion." Worms, dysentery, diarrhœa, uterine irritation, teething, and external injuries are all thought to induce reflex paralysis in certain instances. Diphtheritic and scarlatinal palsies have by some been placed in the same category. The simplest and clearest cases are those of wounds.

The *pathology* of this form of palsy is a subject of much controversy. The best explanation is that of Handfield Jones and S. W. Mitchell; expressed in the term proposed by the former—"inhibitory action." In other words a *morbid* impression, from injury or disease, in one part of the body, being transmitted along a nerve to a nerve-centre, overwhelms or paralyzes it; this effect being shown, of course, in the parts to which it distributes nervous branches.

TREATMENT.—In true reflex paralysis, of short or moderate duration, the removal of the irritant cause produces instant relief; as in H. Jones' case, where strabismus from palsy of the external rectus oculi muscle disappeared after a piece of dead bone was extracted from a whitlow on the thumb; or Lawrence's, in which blindness of one eye (of thirteen months' standing) was cured by

the extraction of a carious tooth, with a splinter of wood projecting from one of its fangs. When the nature of the case does not admit of such prompt relief, if the diagnosis be clear, the same indication remains ; to address our remedial measures to the seat or source of peripheral irritation. Palliate, if we cannot cure, the trouble there, and we will obtain palliation, if not relief, of the reflex disability. Electricity has proved signally useful in the subsequent treatment. This form of disorder is, however, very rare.

Diphtheritic Paralysis.—After the termination of an attack of diphtheria, commonly within three weeks, the muscles used in swallowing and speaking, less often those of the upper and lower limbs, and the sense of sight, may be partially paralyzed. Loss of sensibility usually accompanies the loss of motor power. This condition of things may last for weeks or even months, but is generally recovered from. Whether the immediate cause of the paralysis is the peripheral lesion of the nervous terminations (in the pharyngeal and laryngeal affection) or the toxæmic influence, upon the nerve-centres, of the morbid poison of diphtheria, cannot yet be decided. In extended palsy as a sequela, the latter is the more probable explanation.

TREATMENT.—Passive exercise, stimulating frictions, and electricity, sometimes with change of air, and sea-bathing, are suitable measures for this affection.

Syphilitic Paralysis.—The most unequivocal instances of this nature are accounted for by periostitis within the cranium, involving the dura mater, or, by nodular exostosis, pressing upon the brain. The most remarkable fact connected with such cases is the recorded experience showing the prompt curative effect upon it of *iodide of potassium.* Obscure paralysis, without apoplectic symptoms, and in a syphilitic constitution, may be tentatively so treated, on the basis of such experience.

Lead Palsy.—Considerable time of exposure to the influence of lead is generally necessary to cause this. So commonly does it first affect the extensor muscles of the forearm, that the cognomen of "wrist-drop" is often applied to it. When it lasts for some weeks, the muscles waste away. A blue line is observed to form along the edge of the gums. Pain precedes the palsy, and attends recovery of power. During the attack, the muscles have their excitability by electricity considerably diminished or lost.

Mostly, though after a long time, lead palsy is recovered from. Iodide of potassium appears to act as an eliminant of the lead accumulated in the system. Ergot is asserted by some to be curative also. Faradaic electricity has been found decidedly beneficial; used in moderate strength for a few minutes two or three times a day.

Mercurial Palsy is occasionally met with in those who work in the metal. Mostly *tremor* is a predominant symptom. Early withdrawal from the influence of the cause, and the continued use of the iodide of potassium, are the principal measures of treatment.

Paralysis agitans, or shaking palsy, is described as a more or less constant involuntary and uncontrollable shaking of the hands, arms, head, or, progressively, of the whole body. Slight or moderate degrees of such tremor are common enough, from general

nervous debility. Extreme cases evince the wreck of the cerebro-spinal system, and are therefore incurable. No special treatment can be pointed out for this affection.

Wasting Palsy. (*Cruveilhier's.*)—A few of the muscles of one limb, or the voluntary muscles of the whole body, may lose their power, and then waste away almost to nothing. The shoulder and the ball of the thumb are frequent points of commencement for the palsy and atrophy. Insidious in its approach, the affection may last from six months to several years. It may end in recovery, in permanent arrest at a certain stage of the disease, or in death. Twelve months is the earliest recorded period for the occurrence of a fatal end. This end is the result always when the *trunk* is invaded. After death, the spinal marrow has been examined in but a few cases. No lesion has been found in most of them; in a certain number it has. But our methods of inspection of nervous tissue are yet too imperfect for it to be pronounced that such an atrophic disease is independent of the nervous centres. It may be the *ganglia* which regulate *nutrition* that are in fault.

General Paralysis of the Insane.—Only a minority of insane persons have this affection. Delusions of an extravagant kind commonly attend it. Difficulty of speech, and general tremor, characterize it, followed by the gradual loss of all muscular and sensory power. By the use of the ophthalmoscope, atrophy of the optic nerves has been frequently detected in it. It is incurable.

Locomotor Ataxia. Duchenne's Disease.

Rheumatoid pains, in this affection, precede loss of power. Occasional strabismus and incontinence of urine may occur. Then there is an awkward, unsteady gait; the sensibility of the feet becomes blunted; and walking is insecure. If the patient shuts his eyes, he falls down; and even with them open he reels as if drunk. The duration of this progressive disease varies from six months to ten or twenty years. It is most common in males of middle age. That this is a spinal affection is obvious. Sclerosis of the posterior columns of the cord has been several times found after death. In its *treatment*—hygienic management, general tonics, electricity, and very careful use of strychnia, may be tried, without much hope.

Epilepsy.

DEFINITION.—Periodical convulsions, with unconsciousness during the attacks.

VARIETIES.—*Grand mal* and *petit mal* of the French; the latter is the *eclampsia minor* of some writers; in which unconsciousness occurs with little or no convulsion.

SYMPTOMS.—*Premonition* occurs in a minority of cases before an attack; headache, dizziness, terror, spectral illusions, or the epileptic *aura*. This is a creeping or blowing sensation, like that of a current of air or stream of water, beginning in a hand or foot, and extending toward the trunk. It (if it occur) immediately precedes the paroxysm. Then, often with a scream, the patient falls down, and is violently convulsed. Foaming at the mouth, grinding of the teeth, and biting of the tongue, are common; the

face is flushed, the eyeballs roll, the pupils are unaffected by light, sometimes vomiting, or involuntary urination or defecation takes place; and respiration may be very laborious.

The fit lasts on an average from five to ten minutes. The interval between the attacks may be from several months down to a few hours. Old cases (as in lunatic asylums) may have two or three paroxysms daily. They vary much even in the same individual.

The condition after the attack is also various. Generally, drowsiness or deep sleep follows it; or headache, debility, or delirium; sometimes maniacal frenzy. Homicide has been committed in this state; for which, of course, the person is not criminally responsible.

Anatomy and Pathology.—Epilepsy is not often the immediate cause of death. Autopsies of epileptics (Schrœder van der Kolk) have shown changes especially in the medulla oblongata; dilatation of the bloodvessels being prominent. Exaggeration of reflex motor excitability, with loss of the controlling power of the brain over the spinal axis, would seem to be parts, at least, of the morbid condition. Marshall Hall's idea of "trachelismus," or temporary partial asphyxia from spasm of the muscles of the neck, has been exploded. Brown-Séquard's theory of the importance of the *aura*, as indicating a peripheral irritation at its seat, has, after causing the tentative amputation of a few limbs, suffered the same fate.

Diagnosis.—From *hysterical* convulsions, which also may be periodical and violent, those of epilepsy are distinguished by the total loss of consciousness, which is partially retained during the hysterical paroxysm. Curability belongs also much more to the latter than to the epileptic disease.

Prognosis.—Few cases of genuine epilepsy recover. The younger the patient, and the longer the interval, the more hope. Life may last indefinitely with the disease. Gradually, in most cases, the mental faculties are impaired.

Causes.—Hereditary transmission of this disease is common. Intemperance, venereal excess and self-abuse, blows on the head, and fright, are among the most frequent exciting causes.

Treatment.—During the paroxysm, when habitual, little or nothing is to be done. Place the patient so that he cannot strike his head or limbs against anything hard; loosen the clothing about the neck to favor free respiration and circulation; and insure fresh air about the patient; that is all. An *occasional* convulsion requires treatment; of that more will be said hereafter. (See *Convulsions.*)

To break up the recurrence of the fits is the problem, for which a vast number of remedies has been tried in vain. To name them would be to go over almost half the materia medica. Prominent, since nitrate of silver was generally abandoned as useless, in this disease, have been belladonna, arsenic, valerianate of zinc, digitalis, and bromide of potassium.

Self-management is very important to the epileptic. Temperance, with *nutritious* diet, as the disease is one of *asthenia*, is necessary. Regularity of the evacuation of the bowels is a *sine*

quâ non. Abundant exercise in the open air, short of exhaustion, does good; systematic gymnastics have even *cured* some cases. They are worth trying always. Avoidance of, or the extremest moderation in sexual intercourse must be insisted upon. Self-abuse will make recovery impossible. Tobacco ought not to be used. As the attacks may come very suddenly, prudence is necessary, to avoid serious accidents.

A seton kept in the back of the neck is well worth trying in every case.

Catalepsy.

This is a periodical disease, in which the attack is marked by unconsciousness, and fixed rigidity of all or many of the voluntary muscles. It is rare. The attack generally lasts but a few minutes. Sometimes, in lunatics, a semi-cataleptic state of the muscles is permanent.

There is no special treatment appropriate for this affection. Management like that suitable for the epileptic will be in place also in catalepsy. Both are now so well understood to be asthenic disorders, with impaired *hæmatosis* (blood-making) as an important element, that all reducing measures are properly omitted from their treatment. This must be essentially tonic and *analeptic* or restorative.

Convulsions.

These may be classified as *infantile*, *epileptic*, *parturient* and *puerperal*, *hysterical* and *occasional* convulsions.

During infancy, causes which in an adult would cause delirium, produce convulsions; excito-motor action having in early life the predominance. They are, usually, of less serious prognosis in the infant than in the adult.

The *exciting* causes of infantile convulsions are numerous. Constipation of the bowels; indigestion; worms; irritation of the gums in teething; and excitement of the brain, as by fright, are about the most frequent. Many acute and chronic diseases of infancy (*e. g.*, scarlet fever, meningitis, hooping-cough, etc.) have convulsions among their occasional symptoms or complications. Sudden drying up of eruptions on the scalp may bring them on, also.

Premonition of a fit is often observed, in the child's fretfulness, or restlessness, or gritting of the teeth in sleep. When a fit comes on, the muscles of the face twitch, the body becomes rigid at first, then in a state of twitching motion; the head and neck are drawn backward, the limbs violently flexed and extended. Sometimes these movements are confined to certain muscles, or are limited to one side. Nurses call by the name of "inward fits" cases in which the limbs move but little, but the countenance is affected, the eyes are unnatural in expression, or roll spasmodically, and the body is more or less rigid. Sometimes one attack is followed by another, with intervals of conscious or unconscious quiet between, for many hours. These are the most serious cases, although recovery often happens even from them. *Salaam* convulsions, or nodding convulsions of infants (eclampsia nutans), are a rare form of disease, usually the precursors of epilepsy.

Treatment.—Ascertain, if possible, the *cause* of the convulsion. If the gums are swollen, or have been tender and irritated, at the time of teething, lance them freely; dividing the tense gum with a sharp gum-lancet down to the coming tooth. If the bowels have not been moved, or if the abdomen be swollen and tense, give at once an enema, of castor oil, soap, and molasses, or some other laxative material, with warm water. When the head is hot, apply cold water all over it, by wet cloths, renewed every two or three minutes. If the fit lasts long enough for it, place the child in a warm bath; supporting, of course, the head while the body is immersed. Then mustard plasters may be applied, to the back, epigastrium, and legs, at once or successively.

Cupping the back of the neck, in some cases where time is allowed by a protracted fit, may be resorted to; especially dry cups.

Etherization, so much used by some practitioners in puerperal convulsions, requires more caution in its use in infants. It is less used in the convulsions of childhood; but it may be regarded as justifiable in an obstinate case at any age; watching its effect.

Chorea.

Synonym.—*St. Vitus' Dance.*

Symptoms.—Incessant and irregular movements of the voluntary muscles, over which the will has but partial control. Walking, in severe cases, is difficult or unsafe; the hands cannot be regulated enough to write or work; speech may be affected; the muscles of the face often twitch grotesquely. During sleep all these movements cease. The pupil is, in some cases, unnaturally dilated; palpitation of the heart may occur; and also constipation and indigestion. The urine is of great density.

Prognosis.—The mean duration of chorea is about four weeks; but it may last for several months. Recovery, if the attack be uncomplicated, may nearly always be anticipated.

Complications.—Endocarditis and pericarditis have been observed in connection with chorea in a number of cases. Generally, however, the affection of the heart precedes the chorea; both probably depending on the same cause, *rheumatism.*

Paralysis complicating chorea increases greatly, of course, the seriousness of the case. Although it may be of the transient, hysterical form, yet the danger exists that it may be the result of organic lesion (as softening) of the brain or spinal cord.

Causation.—From six to sixteen, in both sexes, especially often, however, in girls, chorea occurs. Nervous debility is almost always present before the attack. Fright is a frequent cause. Over-fatigue, or mental excitement, blows or falls may produce it. Rheumatic fever is sometimes followed by it.

Treatment.—Good diet, salt bathing, and systematic gymnastic exercises (light gymnastics or calisthenics) will suffice for mild cases. Where marked anæmia exists, iron (citrate, phosphate, or pyrophosphate, tincture of chloride, syrup of iodide) is important. Obstinate cases may be treated with Fowler's solution of arsenic, in small doses, gradually increased, Cimicifuga has been a good deal used, perhaps with benefit. Cod-liver oil should be given if great debility exist. *Calabar bean* has recently been introduced

as a remedy in chorea; gtt. v to f℥ss of the tincture, or from gr. j to gr. vj of the powder thrice daily.

It is well to separate a child having severe chorea from other children; both because of the annoyance of their curiosity, and because *sympathetic irritation* sometimes extends the affection from one to another. This has been repeatedly observed.

Tetanus.

DEFINITION.—A disease characterized by continued tonic contraction of the voluntary muscles generally.

SYMPTOMS.—Stiffness of the muscles of the jaws commonly begins the attack. This extends to the throat and neck, face, trunk, and lastly to the limbs. Though never ceasing entirely, the spasm of the muscles is paroxysmally increased. Sometimes *opisthotonos* occurs, *i. e.*, arching of the body upon the back and heels, the abdomen projecting; or *emprosthotonos*, arching forward, the face approaching towards the toes. *Pleurosthotonos*, or lateral curvature, is much more uncommon.

Chewing of food is impossible; swallowing nearly or quite so; respiration becomes very difficult. The patient suffers dreadfully, and cannot sleep; but delirium scarcely ever occurs. Death in most cases takes place within a week.

VARIETIES.—These are, tetanus from cold (idiopathic), traumatic tetanus (from an injury), and *trismus nascentium*, or tetanus of infancy. The first is the least certain to be fatal.

CAUSATION.—This is principally included in the above. Much the greater number of cases results from lacerated and punctured wounds; but amputations and other operations may be followed by tetanus. Irritation (not inflammation) of the ends of sensitive nerves, transmitted to the spinal cord, produces the reflex spasm, whose general extension and continuance prove fatal. Strychnia, in poisonous doses, causes a similar state. While there can be no doubt that the spinal marrow is the seat of the disease, no characteristic organic change has been found in it; sometimes not even congestion.

TREATMENT.—A tablespoonful of whisky (to an adult) every two or three hours, with milk or beef-tea, and a grain of opium every three or four hours, may be given. The opium may be, if needful, increased to a grain every hour at night, and every two hours through the day.

Chloroform and other anæsthetics, by inhalation, have been tried, with variable effect; nearly always without success. Belladonna, aconite, hydrocyanic acid, cannabis indica, tobacco, woorara, quinine, hydrate of chloral, and Calabar bean (physostigma), are among the many medicines favored by different practitioners. In so desperate a disease it is excusable to give them all further trial. The late Dr. Joseph Hartshorne used vigorous counter-irritation all along the spine, by the decoction of cantharides in turpentine (linimentum cantharidis).

Hydrophobia.

SYMPTOMS.—A month or more after the bite of a mad dog or other rabid animal, the wound having healed, irritation is felt in

it. Nervous restlessness also exists; which increases (in most cases) to violent, angry delirium. Then difficulty of swallowing occurs, from a spasm of the muscles of inspiration (gasping) taking place at the moment of deglutition, making the patient choke. The same spasmodic gasping is brought on by any sudden impression; as of sound, a flash of light, or even a current of air passing over the face. Insomnia exists; the patient grows prostrate, and must die for want of food and drink, even if the affection of the cerebro-spinal axis were not itself fatal. There is intense thirst, and no dread of water, except that the attempt to swallow it causes distress. Death occurs in from four to eight or ten days.

There is not satisfactory evidence that a case of genuine *rabies canina* or hydrophobia has ever been cured. By statistics, however, only one in eleven (some say one in five) of those bitten by mad dogs have the disease, even when no precaution is taken.

TREATMENT.—If we cannot cure, what can or should we do? We may certainly promote *euthanasia*, by allaying the wretched sufferings of the patient, by nitrous oxide, ether, or chloroform.

Hypodermic injection of atropia or morphia might, perhaps, more effectually quiet the suffering, and even afford more possibility of cure, than inhalation of anæsthetics. The hot dry air-bath has lately been proposed.

PROPHYLAXIS.—The only perfect safety to one who is bitten by a rabid animal (and the bite of a much *enraged* dog, not rabid, is said to have also caused *hydrophobia*) is an immediate and total excision of the part. While awaiting this, forcible suction will aid in removing the poison; and ligation with any kind of bandage above the part will retard the absorption of it. When excision cannot be safely performed or is refused, cauterization is the next best thing. Free application of lunar caustic, or of a hot iron, is recommended. Even if the person bitten is not seen until a day or two afterwards, excision or the use of the caustic is to be recommended, as lessening the danger of this horrible disease.

It is well to know that canine madness is not restricted to, nor even especially frequent in, hot weather.

Hysteria.

From its occurrence nearly always in females, and from a supposition of its originating in some affection of the womb, this name has been given to a variable disorder, of which the main characteristic is, *morbid excitability of the whole nervous system.*

A "fit of hysterics" is a paroxysm whose nature may vary, from mere uncontrollable laughter or crying, to a severe epileptiform convulsion. This last, however, differs from epilepsy, in there being less complete loss of consciousness, and in its curability. It is often preceded by a sensation (globus hystericus) like that of a ball rising towards the throat.

Simulation of other diseases, indeed the assumption of severe functional disorders of different organs, is a common trait of hysteria. There may be hysterical amaurosis; hysterical insanity is not uncommon; nor is hysterical paraplegia or coma rare. Retention of urine, cough, aphonia, etc., are often thus produced.

"Phantom tumor" is among the most curious of such things. "*Bed case*" is the name given to the complaint of a hysterical valetudinarian, who believes herself to be ill or powerless, while there is really nothing the matter, except the morbid *neurosis* itself.

TREATMENT.—Much skill and care will often be required in the management of hysteria; as each case has peculiarities of its own. Generally, a tonic regimen is demanded. Iron and cod-liver oil are most often the appropriate medicines. Bromide of potassium is sometimes quite useful. For a paroxysm of "hysterics," assafœtida is universally safe and suitable; in pills of three grains each, *pro re nata.* Sinapisms and pediluvia are also proper. Menstruation is often irregular in hysterical women; it should be regulated as far as possible. Exercise in the open air is, as a rule, very important for such persons. Mental and emotional excitement should be avoided; but tranquil, even engrossing, *occupation* will be beneficial. For hysterical paralysis, electricity is said to be promptly useful. Cold bathing, especially the shower bath, or sea bathing, when followed by reaction, will do good. Feeble and delicate persons, should, however, be careful not to remain in the bath too long. In the surf, for example, a bath of five or ten or fifteen minutes may be of great service, when a longer time would do real harm.

Neuralgia.

DEFINITION.—Pain, without inflammation or other disorder, except that of the nerve or nerve-centre involved; literally *nerve-pain.*

This may affect any of the sensitive nerves. It is, also, sometimes referred to parts which have, in health, no sensibility; as the heart, stomach, etc. Different names are given according to its site. Thus, *tic douloureux* is facial neuralgia; *hemicrania*, that affecting one side of the head; *sciatica*, that of the hip; *gastrodynia*, neuralgic pain in the stomach; *pleurodynia*, in the side. Angina pectoris is, chiefly, a neuralgic affection of the heart.

The pain is generally acute, shooting or darting; with tenderness of the part upon pressure. There is, however, no heat nor swelling, nor throbbing of the bloodvessels in pure neuralgia. Complicated cases occur, in which inflammation and neuralgia exist together; and inflammation of the fibrous neurilemma may be the immediate cause of the neuralgic pain.

PATHOLOGY.—At least three sources of this sort of pain are possible. 1. Local disease affecting a *nerve;* 2. A morbid state of a sensorial *nerve-centre;* 3. A morbid condition of the *blood.* Neuralgia always fixed or returning in the same spot, is likely, although not certain, to depend upon a fault in the nerve itself; as *e. g.*, *neuroma* (tumor of a nerve). Radiating pain (although possibly of reflex origin) must involve at least part of a nerve-centre. Flying pains, never long seated in one part of the body, mostly are due to a defect, or morbid poison (as that of gout, or malaria) in the blood.

TREATMENT.—This must of course depend upon the cause or nature of the case. *Tic douloureux* often depends upon decay of

the teeth; if so, they must be attended to. Other purely local neuralgias require local treatment. Even division of the affected nerve is sometimes, but should rarely be, resorted to. Laudanum or paregoric, applied by saturating a rag and laying it upon the part, covered by oiled silk to prevent evaporation, is an efficient local anodyne. So is chloroform, similarly applied; it is very pungent, burning like mustard. Sinapisms will sometimes relieve promptly. Mere warmth, as of flannel steeped in hot water, will do so in some instances. Rubbing for a few minutes with saturated tincture of aconite root, until the skin tingles; or the application of ointment of veratria (gr. xx in ℥j of lard) may be used in severe cases. In the most obstinate ones, a blister may be applied, dressed, after removal of the cuticle, with two grains of acetate of morphia, diluted with ten grains of gum Arabic. Carbolic acid is a powerful local anæsthetic, though (unless diluted with oil or glycerin) very irritating or caustic to the skin. Or, most prompt usually of all, *solution* of morphia may be hypodermically injected, to the amount of one-fourth drachm to one drachm at once. Sometimes the inhalation of ether, nitrous oxide, or chloroform is resorted to, for the relief of intense neuralgic pain. Debility predisposing to it, in some cases moderate doses of some alcoholic stimulant will give relief.

Of anodynes internally used, belladonna has, for neuralgia, the greatest reputation. It will not quell suffering so directly as opium or morphia, but it has been thought more entirely to do away with the neuralgic state. For this, however, *iron*, especially in combination with quinia or strychnia, is the most effective medicine. Cases of neuralgia which will not be benefited by iron are decidedly exceptional. Larger doses of it are generally recommended for this than for other cases requiring chalybeates. Quinia is particularly wanted in neuralgias of malarial origin (very common); and strychnia or nux vomica in those whose obstinate persistence depends upon great loss of nervous energy. Everything that recuperates, as generous diet, change of air, sea-bathing, etc., will assist in curing neuralgia, when it is connected, as it so often is, with anæmia and broken health.

Odontalgia, toothache, is sometimes purely neuralgic. More often it results from exposure of the nerve by the decay of the tooth. Again, it may attend *inflammation* of the jaw, or abscess at the root of the tooth affected. For toothache from *exposed nerve*, *creasote* is a certain remedy. Insert carefully into the hollow a plug of cotton, wrapped over the end of a knitting needle and dipped in pure creasote. If the latter run out into the mouth (which should be avoided if possible) rinse it at once with cold water.

Delirium Tremens.

SYNONYM.—*Mania a potû.*

SYMPTOMS.—Sleeplessness, debility, tremors, horror, hallucinations; often with loss of digestive power. The *insomnia* is a cardinal symptom; if the patient sleeps a whole night he recovers. Debility varies in degree in different cases; in a first attack it is not always great. Tremor is nearly always present.

The illusions of the patient are wonderfully real, and usually dreadful. He is pursued by demons or beset by mortal enemies; he cannot bear to be alone, especially in the dark. Sometimes, however, the visions are indifferent, or even amusing. The patient may suppose himself to be well, and engaged about his usual avocation; going through all its movements in pantomime, though with empty hands.

After several days and nights of sleeplessness, prostration usually increases; the skin grows cold and clammy, the voice feeble, and the patient no longer inclines to move about. Death must result, if sleep be not obtained, within a week, or, at the most, two weeks. In favorable cases, a sound sleep of many hours comes on within three or four days; the patient then wakes up rational and well.

Causes.—There is no room for doubt that this affection may come on under two different conditions or circumstances: 1, where stimulants are suddenly withdrawn from one accustomed to them; and 2, while their use in excess is continued. The second class furnishes the most dangerous cases.

Treatment.—Old as this disease is, it is yet the subject of great difference of opinion. If the patient be not much prostrated, give only ale or porter, a bottle or two in the day; with hop tea *ad libitum*, and a grain of opium every three or four hours. The latter may be increased, if sleep be delayed, to a grain every two hours; or, as a maximum, a grain every hour. Very weak patients, accustomed to spirits, might have a tablespoonful of whisky or brandy every four, three, or two hours, according to their condition. Hydrate of chloral sometimes answers as well as, or better than, opium. Beef-tea and mutton-broth, etc., seasoned with red pepper, are preferred as diet. In an obstinate case, sleep may follow the raising of a blister upon the back of the neck. Substituting valerian for opium, or combining the fluid extract or tincture of valerian with morphia solution, answers well in some cases. Injection of laudanum into the rectum is occasionally resorted to.

Other modes of treatment have been urged. 1st. The *expectant* treatment, of Drs. Dunglison and Laycock; giving only strong food, without stimulants or opium. 2d. The treatment by tablespoonful doses of tincture of digitalis. 3d. That by the internal use of chloroform, in one or two drachm doses.

The digitalis treatment, bold as it seems, has a good deal of positive testimony in its favor. Why not try, as some do, less immense, and yet large doses; as half a drachm or a drachm, instead of half an ounce, of the tincture, every three or four hours?

Dr. E. McClellan and others have recently reported excellent success with one or two drachm doses of chloroform. The corrugated stomach of a spirit drinker will probably bear the pungency of chloroform better than another's. Generally only one or two such doses of it are said to be required.

The large majority of first attacks of mania a potû are curable. Third and fourth attacks are often fatal, or are followed by permanent insanity.

CHAPTER X.

DISEASES OF THE SKIN.

As a clinical classification of cutaneous disorders, most convenient both for description and treatment, I prefer the following :—

Exanthemata.	Pustulæ.	Tuberculæ.
Papulæ.	Squamæ.	Hemorrhagiæ.
Vesiculæ.	Maculæ.	Neuroses.
Bullæ.	Hypertrophiæ.	Parasiticæ.
	Syphilida.	

Exanthemata.

In these, there is active congestion or hyperæmia of the "derma" or true skin. Besides scarlatina, measles, and erysipelas, already considered, this order contains *erythema*, *urticaria*, and *roseola*.

Erythema.—Superficial, circumscribed red patches, of variable shape and size, on the face, trunk, or limbs, not painful nor very sore, characterize this. Its causes are, all moderate but somewhat continued irritants to the skin. Its duration is generally but for a few days or a week or two. No fever attends it ; nor is it either contagious or dangerous.

Varieties[1] of erythema are, *erythema fugax*, or fleeting ; *erythema intertrigo*, from friction of two surfaces of the skin, as in not well-cleaned children ; *erythema rheumatica*, occurring now and then in rheumatic fever ; *erythema pernio*, or unabraded chilblain ; and *erythema nodosum*, on the legs, with rounded node-like prominent red patches, somewhat more inflamed than in the other forms.

Treatment of erythema must depend upon its cause more than upon its particular form. The stomach and bowels may need attention, with the use of antacids and laxatives ; especially magnesia and rhubarb, or Rochelle salts, or the citrate of magnesium.

Local applications may be, finely-powdered starch or arrowroot, dusted on, dry ; cold cream (unguent. aq. ros.) ; lime-water and oil, equal parts (olive, or lard oil) ; ointment or glycerite of zinc ; glycero-cerate of lead ; or glyceramyl.

For erythema *pernio* or frost-bite of mild degree, astringents are serviceable ; as bathing the feet in tepid infusion or decoction of oak bark, or solution of alum ; or applying cerate or glycerite of carbonate or nitrate of lead. Some recommend cabbage leaves.

Urticaria, *Nettle-rash*.—Elevated round or oval, red or white,

[1] Here, as in other affections of the skin, only the *principal* varieties are named. Wilson makes sixteen varieties of erythema.

patches or *wheals* characterize this. They may come and go in an hour, over the arms, trunk, or legs. Much burning, stinging, or itching attends them. The affection commonly lasts only a week or two; sometimes it is chronic and tedious.

Disorder of the stomach (as from unwholesome food) is rather more likely to cause nettle-rash than any other kind of eruption. Mild purgatives, especially salines or the antacid magnesia, with or without powdered charcoal, are commonly suitable for it, after a dose (two or three grains) of blue mass. Light diet is necessary. Vinegar and water, glycerin and rose-water, or the starch-powder, etc., mentioned for erythema, will answer for local applications. Much use of *cold* lotions should be avoided, lest the eruption be over-hastily repelled, inducing gastric, hepatic, or other internal disturbance.

Roseola. — Bright, and yet generally *dark* red, damask rose-colored patches, irregular in shape and of various size, over any part of the body, without much if any fever, belong to this affection. It is generally of but a few days' duration. Sometimes a certain amount of resemblance is presented by it to scarlet fever or measles; but the peculiar sore-throat of the former, and the catarrhal symptoms of the latter, are wanting.

Scarcely any treatment is called for in roseola; no local application, as the rash is but slightly irritating; and only such medicines as the general condition of the patient may indicate.

Papulæ.

These, *pimply* eruptions, involve *depositive* inflammation of the skin; which is raised in small, red, round, or conical points or minute tubercles, not very hard, and often, though not always, transitory. Papular affections are *Lichen* and *Strophulus*.

Lichen.—Pimples numerous, but of small size; red, and more or less heated and irritated. The principal forms of it are *lichen simplex*, common on the face, neck, etc., *lichen tropicus*, or *prickly heat*, and *lichen agrius*. The last named is the most inflamed and painful; sometimes quite severe. Lichen *simplex*, though mild, may be obstinate in its persistence; annoying ladies, sometimes, by remaining long on the face. In lichen *tropicus*, from which children, especially, often suffer in summer time, the eruption is not prominent, but the sense of irritation is very unpleasant.

Lichen *agrius* may become, in violent or neglected cases, a scabby confluent eruption, with cracks or fissures, and a serous, perhaps purulent discharge. This is not, however, very common.

Treatment.—Even for the simple form, and still more for lichen agrius, constitutional alteratives are likely to be needed, doing more good than local applications. In lichen tropicus, starch powder, glycerin and rose-water, or glyceramyl, or weak lead-water will suffice, without any medicine. But in the other forms, rectification of any error of *balance* in the system must first be made. The plethoric must have low diet; the anæmic, lean meat, perhaps bitters, aromatic sulphuric, or nitric acid, or iron. Costiveness must be overcome, as by cream of tartar and sulphur, rhubarb and aloes, or other mild but decided laxatives. Blue mass may be given, a grain twice daily for two or three days.

Then, arsenic may be prescribed; of Fowler's liq. potass. arsenit., three drops twice daily at first, increased every week one drop until ten twice daily have been taken; omitting the remedy if headache, nausea, diarrhœa, or puffiness of the face occur.

In lichen agrius, rest in bed may be required; with lime-water and oil dressing, or poultices of bread and milk, or flaxseed meal, or slippery elm bark powder, glyceramyl, etc.

Strophulus.—Red gum is a common name for this papular eruption of infancy. Indigestion, reflex irritation from dentition and over-thick clothing or living in hot rooms, may produce it. The eruption is not severe, consisting of many small red pimples, close together, and often nearly all over the body. Attention to the stomach and bowels is necessary. *Lancing the gums is proper* if they be swollen, tender, or so tense as evidently to distress the child. To the rash, only very soothing applications should be made, as starch-powder, ointment of oxide of zinc, or glyceramyl. Care with the diet, if fed instead of being nursed, is of course also of great importance.

Vesiculæ.

These are *effusive* inflammations of the derma; characterized by numerous and small water blisters; the smallest are *sudamina;* the largest, *herpes; eczema* having vesicles of intermediate size, and scattered. *Sudamina* are met with in low fevers, consumption, etc., mostly when perspiration alternates with the febrile state in an enfeebled system.

Eczema.—This has been the subject of much disputation; as to whether it is a *disease per se*, going through stages not only of effusion, but also of incrustation, suppuration, desquamation, etc.; or, only a phase of cutaneous irritation and inflammation, called vesicular, whatever its cause, and eczematous to distinguish it from the hepatic eruptions. Unable to decide this question with positiveness, we may say, merely, that, while the eczematous vesicular eruption admits of very distinct description and recognition, it may come from or after a papular rash, and may in the same case be transformed (or progress) into a pustular or scabbing disease.

Eczema *simplex*, *rubrum*, *infantile*, and *impetiginodes* are its principal varieties. Besides others named in the books, there are also eczema *solare*, from heat, and eczema *mercurialis*, from the impression of mercury on the system. The *simple* form has but little inflammation; but there is always some soreness, and the vesicles may run together and break, oozing serum or lymph, or scabbing lightly. Eczema *rubrum* is more inflamed, with redness, heat, and some tumefaction. *Crusta lactea*, or milk crust, is a name often given to eczema *infantile* of the nursing time. It affects the face, sometimes very unpleasantly; scabbing, running, and cracking all over it. E. impetiginodes appears to be an intermediate stage, or transition, between eczema and impetigo; water blisters appearing at first, and pustules afterwards.

Treatment.—An inflammatory state attends the eczematous eruption, nearly always; especially in *eczema rubrum* and advanced *crusta lactea.* Saline laxatives, diuretics and diaphoretics (Ro-

chelle salts, bitartrate of potassium, citrate of potassium, etc.) are often called for, perhaps to be repeated in moderate doses. Light diet is, in like case, proper. In children, small doses of calomel occasionally do good. Locally, weak lead-water when there is no scabbing; lime-water and oil when there is great irritation; decoction of bran; flaxseed infusion with bicarbonate of sodium (℈j in f℥iv); glyceramyl; glycerin with rose-water; carbonate of lead cerate; ointment of oxide of zinc; these are among the many applications used with advantage. The whole bath, tepid or slightly warm (never hot), two or three times a week, will be beneficial. In chronic eczema, the "Turkish" or dry, hot air bath (130° to 150°) is highly recommended by some.

Chronic eczema requires alterative treatment internally. Arsenic is *the* alterative, par excellence, in obstinate cutaneous affections. Its peculiar action on the skin tends to displace the morbid process, and thus to restore, after its own transient influence is withdrawn, healthy nutrition and reparation. Five drops of Fowler's solution may be given at first, twice daily, increased gradually until the dose amounts to ten drops; sometimes even more. The medicine must be intermitted, if the head, stomach, or bowels show its decided action. In case of its failure, particularly where syphilitic taint is possible, Donovan's solution (liq. arsenici et hydrargyri iodidi) may be given; three drops at first, cautiously increased. Scrofulous or otherwise feeble children may need cod-liver oil. In *crusta lactea*, or *eczema infantile*, the mother or nurse must be instructed not to burden the child with clothes, nor keep it in an overheated room. Daily bathing is particularly important to an infant suffering with such an eruption.

Herpes.—This has larger, more separated and less numerous vesicles than eczema; it is less apt to be chronic. Varieties: *herpes phlyctenodes*, *herpes zoster*, and *herpes circinatus*. The first is the most frequent; receiving also local names, according to its seat; as *h. labialis*, *præputialis*, etc. *Herpes labialis* is commonly called "fever blisters."

Herpes zoster is singular, and not very common. Half of the body, about the waist, is covered with vesicles, on an inflamed red surface. Sometimes neuralgic pains, quite severe, attend it. It generally affects the right side. Its duration is but for a week or two; unless in the feeble or old, in which it may be followed by ulcerations of a tedious, perhaps dangerous character.

Herpes circinatus is distributed in circular patches or rings. *Minute* vesicles appear around the circumference. By these, and the absence of the microscopic vegetation, and by less disposition to chronicity, it is distinguished from *tinea tonsurans*, or true contagious ringworm. *Herpes iris*, of writers, is an aborted *h. circinatus;* the rings being incomplete.

Herpes rarely appears in old persons; often in children and adolescents. All causes of irritation of the surface of the body may produce it; as febrile or catarrhal attacks, stimulating diet, violent exercise, etc.

For the treatment of herpes, the plan stated for eczema is, in principle, here also suitable. Cucumber ointment may be added to the applications recommended. Herpes *zoster* requires confine-

ment to bed. The severe pains, in this, may call for anodynes. Herpes *labialis* is sometimes very annoying, especially to ladies. Pure *cologne-water*, applied at the very start, may *abort* the vesicles. Magnesia powder is used by some to dust about the lips. Calomel ointment is recommended when the eruption is chronic, coming out in successive crops.

Bullæ.

These are eruptions of *large* vesicles. *Pemphigus* and *Rupia* are the most distinct.

Pemphigus.—Bullæ of a circular or oval shape, from half an inch to two inches in diameter, and flattened. They may be distributed over any or all parts of the body. Fever, sometimes considerable, precedes and accompanies the eruption. After the vesicles mature, they burst, or dry away, leaving thin brown scabs. Ulceration may occur, but it is not deep or obstinate, unless in a particularly unhealthy constitution. The duration of pemphigus is from one to three weeks, or more in bad cases. *Pompholyx* is the name given to a rare variety of pemphigus, in which the space continuously covered by bullæ is large, and there is little or no fever. A fly-blister causes artificial pompholyx.

Pemphigus is not usually considered to be contagious. One family came under my notice, however, in which five individuals were attacked by it, partly in succession, after travelling. It was difficult in that case not to suppose contagion.

In the TREATMENT of pemphigus, gentle refrigerant laxatives at first, diuretics and diaphoretics next, and, often quite early, tonics and supporting regimen, are called for. No local applications, other than the mildest lotions or unguents, will be suitable. The early puncture of each bulla with a small needle is recommended; but the raised cuticle must not be removed.

Rupia is probably but a modification of pemphigus; with smaller blebs or bullæ, followed by thicker conical scabs, of dark color; after whose removal ulcers are left, which may be weeks in healing. Rupia *simplex* is the variety in which the scabs are low and the ulcers slight; rupia *prominens* in which they are elevated into irregular cones; rupia *escharotica*, when the ulceration is deep and extended. *Syphilitic* rupia is quite common; but every case of rupia is not, by authorities, admitted to be syphilitic. Observation goes to sustain this non-admission.

TREATMENT of rupia requires to be, generally, tonic and alterative. Quinine, cod-liver oil, and iodide of potassium, with good but simple diet, are apt to be wanted for it.

Pustulæ.

Suppurative inflammation of the skin (excluding smallpox, furuncle, and carbuncle, as well as the malignant pustule or *charbon* of the French, a rare affection said to be received from cattle) appears in the two forms *Ecthyma* and *Impetigo*.

Ecthyma.—Large, round, prominent pustules, upon any part of the body, not numerous; ending in thick dark scabs, followed by slight (or in cachectic states, obstinate) ulcerations. Ointment of tartar emetic, or pure croton oil, or other strong cutaneous

irritants, will produce it. Often, however, especially in syphilitic persons, or after acute fevers, etc., it occurs without local exciting cause. Sometimes it is chronic.

In TREATMENT the causation is of great importance. If a local irritant produces it, local emollients, perhaps with general refrigerants, are to be used for its relief. Otherwise, diet, and *balancive* measures will be more in place: tonics for the feeble, purgatives and light regimen for the plethoric, etc.

Arsenic is called for in obstinate cases, as in other diseases of the skin; Fowler's or Donovan's solution, in small doses carefully increased.

Impetigo.—Small and somewhat numerous pustules: varieties, *impetigo figurata* and *impetigo sparsa.* I. *figurata* is most common on the face, in circumscribed clusters of pustules, which may become confluent and scab. To this, in children, as well as to *eczema infantile*, the name of crusta lactea is given by authors. I. *sparsa* has the pustules scattered over more or less of the whole body.

TREATMENT.—When much irritation or inflammation exists, lead-water, glyceramyl, ointment of oxide of zinc, lime-water and olive oil, flaxseed tea and bicarbonate of sodium, light poultices of flaxseed meal, slippery elm bark, or bread crumb, are to be applied. Daily use of castile soap and water is serviceable. Purgatives may be needed. Diet must be according to the general condition of the patient. Impetigo may affect the hairy scalp; if so, the hair must by cut and kept very short. Colchicum and ipecac. may be given in acute cases; arsenic in those which become chronic.

Squamæ.

Scaly diseases are, *Lepra* (*Alphos* of Wilson), *Psoriasis*, *Leprosy of the Hebrews*, *Spedalsked*, or Norwegian leprosy, *Pityriasis*, and *Ichthyosis.*

Lepra.—Always chronic, and very difficult to cure. Not regarded as contagious, though it has been seen to occur successively in four persons in immediate contact (an infant at the breast, its wet-nurse, another infant suckled by her, and her husband). It is characterized by red desquamating patches, of various sizes, approximating to a circular shape, on any parts of the body; especially on the arms and legs. Besides syphilitic lepra, its varieties are lepra *vulgaris*, with small patches and few thin scales, and lepra *inveterata* (*alphos diffusus* of Wilson) where they are large and desquamate extensively.

In both, the *margin* of the patch is the highest, reddest, and most squamous part.

Psoriasis.—Described under the names of ps. *vulgaris*, *gyrata*, and *inveterata*, psoriasis differs mainly from lepra in the irregular and varied forms of the desquamating patches; and in the absence or less degree of depression near their centres. Wilson's view, that psoriasis is only a kind of chronic eczema, does not seem to accord with the facts of its ordinary history. It is sometimes hereditary; as also lepra. No disease of the skin is so hard to eradicate, unless it be ichthyosis.

Treatment.—For lepra and psoriasis alike, all sorts of alterative agencies, local and systemic, are, if cautiously used, suitable for tentative practice. Our object is to obtain the *making of a new skin*, unaffected by the morbid habitude of nutrition. Frequent bathing should be practised. Tar ointment, citrine ointment, ointment of sulphuret of potassium, etc., may be applied. Arsenic, and the iodide of arsenic and mercury (Donovan's) should be given, carefully, but repeatedly, through long periods. Other medication must depend upon the conditions of each case.

Ichthyosis (Fish-skin disease).—This is rare. Hard, thick, dry scales form, continuously, over a part, or, sometimes, nearly the whole surface of the body; without much redness, soreness, or even itching. It is congenital and incurable. Frequent and thorough ablutions, and mild emolient applications, are palliative to it.

Pityriasis.—This is a chronic affection in which very numerous small white scales (dandriff) form upon the skin, particularly the scalp (p. capitis). Some redness, and often a good deal of itching, may attend it. It is difficult of cure in many cases. If it be upon the head, keeping the hair short, and washing daily with castile soap, followed by a spiritous lotion, or glycerin and rose-water, will do the best for it. Cleanliness and frequent bathing in tepid, cool, or, if the vigor of the system permit, cold water, are of essential importance in all cases.

The term *pityriasis versicolor* is sometimes applied to an *epiphytic* disease (*i. e.*, one connected with a vegetable parasitic growth), better called *chloasma versicolor.*

Spedalsked is a disorder only known in Norway and Sweden; especially among the fishermen. Accounts of it are given in medical journals and books; but the mere mention of it will suffice here. (See *Elephantiasis Græcorum.*)

Leprosy of the Bible (Lepra Hebræorum) is of great historical interest. It is still recognizable in the East, though not frequently met with.

In the Book of Leviticus, three varieties of leprosy are described; dull or darkish white "freckled spots"—dusky or shadowed—and *bright white* (*bahereth lebhana*), the worst of all. *Tsorat* (whence *psora*, and sore) or malignant disease, was applied to the last two only. *Lepra* is an early Greek synonym of this term.

Mason Good thus describes the old leprosy: "A glossy, white, and spreading scale upon an elevated base; the elevation depressed into the middle, but without change of color; the black hair on the patches, which is of the natural color of the hair in Palestine, participating in the whiteness, and the patches themselves perpetually widening their outline."

In favorable cases, after spreading over much of the person, though without ulceration, the disease would die out; the scales would dry up and gradually disappear. In bad cases ulceration would occur, with extensive sores, as well as desquamation. Then the leper was made an outcast, and treated as one dead: "unclean for life."

Not only the Books of Moses, and others of the Bible, but also Hippocrates, Galen, and Celsus (under the names λέυκη, and λέπρα

λευκη) speak of ancient leprosy as a *white scaly* disease. It thus differs decidedly from any kind of elephantiasis.

Maculæ.

Ephelis, *Vitiligo*, and *Chloasma* may be included under this term; perhaps better, under that of *Decolorationes*.

Ephelis; Lentigo.—Sunburn and freckles best correspond with these names; which, however, are by some authors extended further. Neither are of importance unless in regard to appearance. For the removal of freckles (which often disappear spontaneously with time) or the yellowish-brown spots called *chloasma*, or *melasma*, all applications may fail; dilute nitro-muriatic acid (fifteen to thirty drops in an ounce), left for some time in contact with the discolored spot, is more likely than anything else to take effect. Nitrate of potassium, in saturated solution, is asserted to remove freckles after a few applications.

Vitiligo.—Literally, *veal-skin.* Unnatural whiteness from deficiency of coloring matter. When universal over the body (nearly always then congenital) it is *albinismus.* We see albinoes, sometimes families of them, occasionally, in all the races of mankind; as well as among the lower animals. *Leucoderma*, white skin, and *Leucopathia*, or white disease, are names given by some writers to the affection.

When local, vitiligo is seen mostly in rounded patches or spots, which slowly increase in size, though without regularity of shape. The head, chest, back, and thighs are the most frequent seats of them. The hairs on the parts involved become white; or fall out, causing baldness—*calvities*, or *alopecia.*

TREATMENT, for vitiligo, must be, first, general, for improvement of nutrition in the whole system—and then local. Very hard it may be to cure the affection, although its importance is chiefly for appearance; no danger attends it. *Tannic acid* and *oil of turpentine* are the preferred local applications for it. Total *albinismus* is quite incurable.

Chloasma (pityriasis) *versicolor* will be spoken of under *Parasiticæ.*

For *alopecia*, baldness, or premature loss of the hair, many remedies are in vogue. Shaving the head repeatedly (*i. e.*, after an illness) may often save the hair. Stimulating applications, such as tincture of cantharides, ammonia, etc., sometimes help and sometimes hurt the case.

Hypertrophiæ.

Morbid excesses of development of the skin or tissues connected with it, are thus named: *Nævus*, *Clavus*, *Verruca*, *Elephantiasis Arabum.*

Nævus. (*Mole, mother-mark.*)—This is always congenital. Discoloration and elevation of the part exist, with abnormal development of the capillaries and small veins of the skin; making a small, commonly flat, vascular enlargement. It is seldom more than an inch in diameter. Erectility sometimes belongs to the vessels of nævus.

Caustic, the ligature, the knife, and vaccination of the part, have all been employed for the removal of such formations. They may leave scars worse than the mole ; the operation ought to be exceptional.

Verruca. Wart.—A hypertrophy of the skin, with great development of the cuticle, especially upon a small surface ; such is a wart ; of which no one needs a further description. Some persons and families are especially liable to them ; why, we cannot say.

TREATMENT.—Strong nitric acid; chromic acid; caustic potassa; and in slight cases nitrate of silver, carefully applied only to the wart, after paring off nearly all the insensitive portion of it, will always, at least after repetitions, remove warts.

Clavus. Corn.—Most persons are well acquainted with this sort of localized hypertrophy of the skin of the foot, from irritating friction and intermittent pressure. Prevention is more easy, by far, than cure. Corns are either *hard* or *soft;* the latter may become inflamed ; the former hurt only under decided pressure.

Pare a hard corn with a sharp knife or razor, closely, but *not* so as to hurt or draw blood. Soak the foot then in warm water for five or ten minutes, and pick out carefully the centre or "core." Two or three thicknesses of adhesive plaster, with the centre cut out (making a ring) should be put over the corn ; and another piece, the centre not cut out, may be placed upon it and them.

Soft and *inflamed* corns require removal of all pressure for a while, and poulticing, etc., first ; then the above treatment.

Condylomata.—These are fleshy tumors or outgrowths, more or less hard and wart-like sometimes, in other cases soft ; of syphilitic origin often, but not always. They are especially apt to occur about the anus, prepuce, and vulva.

To remove such formations, if they be small and hard, nitric acid, pure, may be used, with care to limit its contact to the part to be destroyed. When large and soft, if troublesome enough to require destruction, the ligature is generally preferred. It may be, with a needle, passed through the centre of the mass, and then drawn and tied tightly about the base.

Elephantiasis Arabum.—Bucnemia Tropica of Wilson ; "Barbadoes Leg."

Enormous enlargement of the leg, scrotum, or neck, most often met with in warm countries, but occasionally anywhere, is thus called. The parts become at last hard and nearly immovable. The connective tissue as well as the dermoid texture proper is greatly hypertrophied. Impediment to the return of surplus material of nutrition by the lymphatics is the probable pathogenetic cause ; the nature of this impediment has seldom been discerned.

Ligature of a large artery is asserted to have arrested the growth of elephantiasis. No other treatment appears to be equally hopeful for it.

Tubercula.

Acne, Molluscum, Lupus, Elephantiasis Græcorum, Frambœsia, Keloid.

Acne.—Tuberculous elevations, from inflammation of the skin around sebaceous follicles, in which the secretion is detained, or is

of a morbid character, are called *acne*. Three varieties may include all those named by authors: viz., *acne simplex*, *acne pustulosa*, and *acne rosacea*.

Acne *simplex* or *punctata* has small and moderately red, rather hard tubercles, on the face principally. When very hard and chronic, it may be called acne indurata. Black points commonly mark the obstructed follicles. Acne *pustulosa* reaches a more mature suppuration, and is often painful, especially if upon the scalp.

Acne *rosacea* always affects the face; usually in adults, and most often in high livers. A good deal of soreness attends the eruption. First, the pimples are hard, red, and small; as they mature they grow somewhat larger; finally a little sanguinolent pus escapes, leaving a small scab. Rose redness around the pimples, or patches of them, has given rise to the name. It is generally a difficult disease to cure, and very unsightly. Not unfrequently it is hereditary.

TREATMENT.—Errors of digestion, brought on by gluttony or intemperance, or more moderate imprudence, often cause acne. They must be rectified for its cure. Attention to the state of the bowels, and to the action of the skin generally, is indispensable. Saline cathartics are useful in plethoric cases. Various mineral waters are recommended—saline and sulphurous especially. The pustules, when they mature, should be carefully punctured with a needle, avoiding irritating disturbances. Solution of carbonate or bicarbonate of sodium (℈j in Oj) in water or flaxseed infusion, will be a good wash. Sulphuret of potassium, in dilute lotion or ointment, is also advised; or ointment or glycerole of nitrate or amide of mercury (hydrarg. ammoniat.).

Obstinate cases justify more decided alterative treatment; as the application, by a cotton tip upon a knitting needle, of a solution of corrosive sublimate, two to five grains to the ounce of water or alcohol, washing it off in a few moments; or, similarly, of pure Goulard's extract (liq. subacetat.) of lead, followed by spermaceti ointment, cold cream, or glycerin and rose-water. Iodide of sulphur ointment (gr. xv to xxx in ℥j of lard) is also much praised. In acne *indurata*, when very ugly, acid nitrate of mercury (mercury and nitric acid each an ounce) has been applied, and sometimes the face has been blistered with cantharidal collodion.

Molluscum.—Acute molluscum is a somewhat *contagious* tuberculous eruption. The small tumors form without inflammation, increasing slowly, till they have almost the size and form of a currant, but without color, and nearly flat-based or sessile. They last from three to six months, either ulcerating finally and then shrinking away, or inflaming and sloughing off, leaving a pit or mark. Several crops of tubercles may succeed each other on the face and neck, in either adults or children, but especially in the latter.

Chronic molluscum is of still longer duration; it is not contagious, and the tumors are *pedunculated*, *i. e.*, each has a stem, in many cases at least; they also become larger, and occur over different parts of the body. Neither form of molluscum is common. It is proper to add that some authorities do not admit the contagiousness of the acute variety.

Treatment of acute molluscum seems not to be to any great extent available. In chronic molluscum the tumors may be cut off at the peduncle, the divided point being then touched with lunar caustic.

Lupus.—L. *exedens and non-exedens*, or l. *superficialis*, *serpiginosus*, and *devorans* (Neligan). Lupus *superficialis* is a rare disease, in which, most often on the cheek, a small, soft, sore, slow-gathering tubercle appears, which in time scabs, and ulcerates superficially, the scab and ulcer spreading for an indefinite time, and leaving behind them a permanent whitish seam or scar. Irritation may make the tubercle very painful, and deepen the ulcer. It may last for years.

Lupus *serpiginosus* exhibits one or more livid, red, indolent tumors on the face, head, or elsewhere, sore, heated, and itching. In the course of months they become filled with pus, and suffer an undermining ulceration, which finally becomes an open, unhealthy-looking sore, forming upon it a hard, brown scab. Creeping from the edge of its original seat, in irregular rings, the disease extends, leaving behind it a depressed cicatrix. The same part may be again reached by its meandering progress. This is a very chronic affection, even of years' duration, without injuring the general health.

Lupus *exedens* or *devorans* (noli me tangere or *rodent ulcer*) is characterized by continuous destructive ulceration of the skin, subcutaneous connective tissue, muscles, and other parts, at length involving even bones; all following tubercles "rounded and dusky red," on the nose, cheek, eyelid, etc. An ichorous discharge belongs to it; cicatrization follows it, sometimes (as in the previous form) to be again attacked.

Young persons, from ten to thirty, are especially liable to lupus. Its progress is generally an affair of years, and it causes less suffering than its appearance would lead us to expect. Scrofula certainly and probably syphilis, predispose to it. It is very difficult to cure; sometimes, at least, incurable. The obvious alliance with cancer has induced some authorities to place lupus in a class of affections called *cancroid*. It differs from cancer, however, in not involving the glands, nor contaminating the general system. Lupus is a comparatively rare disease.

Iodine (as in Lugol's solution), cod-liver oil, and iron, internally, are commonly indicated in the treatment of lupus, especially the *exedens*. Fowler's or Donovan's solution may also, or each in its turn, be cautiously given. Chlorate of potassium has been suggested. Sea-bathing is likely to assist in the treatment.

Locally, the animal oil of Dippel (made by dry distillation of hartshorn shavings) has a reputation in Europe for lupus superficialis as well as for l. devorans. So have dilute solutions of chloride of zinc, nitrate of silver, nitric acid, etc. In the superficial variety, *collodion*, softened perhaps by adding $\frac{1}{30}$ of glycerin, may be painted lightly over the ulceration, every day or every few days.

Excision is sometimes practised for the exedent form, to prevent disfiguration; but the success of the operation is uncertain. So is that of strong caustics. Among these, nitrate of silver is pre-

ferred by most surgeons. Acetate of zinc, used solid for touching the ulcer, and applied every day or two, was much recommended by Neligan. He used also a lotion of the same salt, from three to five grains to an ounce of distilled water. Broadbent's treatment for cancer, by injection of *acetic acid*, might be worth a fair trial in lupus. Its theory is very plausible.

Elephantiasis Græcorum.—Called by this name among the Greeks, probably because, as the elephant is a great and powerful animal, so is this a formidable disease. It was the leprosy of Europe in the middle ages; for whose treatment many hospitals were built, and an order of Christian knighthood (of St. Lazarus) was established.

It is characterized by many round tumors, from the size of a pea to that of an orange, livid, purple, yellowish or brownish, and soft, on the face and other parts of the body. The skin around them thickens irregularly, giving a repulsive aspect. Ulceration occurs, deepening even to the bones; all the organic functions suffer, and finally the mental faculties become enfeebled; diarrhœa, and perhaps tetanus, precede death.

This disease is probably identical with the *spedalsked* of Norway, already named. Allied to it are *radesyge* of Norway, the *morphie* of Brazil, *frambœsia* (raspberry disease), *Sibbens* of Scotland, and *Aleppo evil* (button of Aleppo); perhaps also the *Ngerengere* of New Zealand. *Pellagra*, of Lombardy, Spain, and France is described by some as having a certain resemblance to it; but tumors do not belong to this disease; in which, with a general cachexia, the skin becomes discolored and somewhat thickened, with arrest of its normal functional action.

TREATMENT of elephantiasis and its allies must be upon the principles laid down for other serious cutaneous affections, *viz.*, to endeavor to *restore the balance of the general functions*, whatever may be wrong; whether that be by tonics, refrigerants, or purgatives, or other remedies acting upon the secretions; also improving the nutrition and repair of the skin, by local and general alteratives. There is no *specific* remedy for either of the forms of disease last named.

Keloid. (*Kelis*, *Keloïs*, *Cheloid*, *Sclerema.*)—This is very rare. Wilson, a few years since, stated that but twenty-four cases of it were upon record; more have been reported upon since. An irregular, cicatrix-like, smooth, reddish and whitish, corrugated excrescence, painful, with a stinging sensation, sometimes, but not always; nearly in every case forming upon the front of the chest; slow in growth, not ulcerating, and not tender to the touch. It is, not unfrequently, spontaneously removed by absorption; but has not been shown to be amenable to treatment. Rayer advises constant firm compression.

Hæmorrhagiæ.

Purpura is the only affection of the skin belonging under this head. On parts, or often the whole, of the body, appear round red spots, which become gradually of a dark purple color; and then pass, as bruise marks do, through green and yellow, till they disappear. They are extravasations of blood in or upon the true

skin from its capillary vessels. The duration of each spot is about a week or ten days. Feverishness may precede, and prostration may accompany purpura. In bad cases, hemorrhages may take place from the mucous membranes, as those of the mouth, stomach, bowels, bladder, vagina, etc.; producing, sometimes, even a fatal result.

Purpura is by some improperly confounded with scurvy. Although extravasation of blood occurs in scorbutus, it may also happen quite independently of it. Deficiency of fresh vegetable food is not at all necessary to engender purpura; the causation and pathology of which, clinical experience and chemical investigation have both failed to show.

TREATMENT.—Although some assert plethora to be, as often as hydræmia (anæmia), antecedent to purpura, experience goes with the ordinary view, that rather a tonic than a depletory treatment is generally called for in it. Excessive stimulation, it is true, will aggravate its symptoms. Mineral acids, as elixir of vitriol, and Huxham's tincture of bark, or quinine, etc., are much given. Oil of turpentine is also recommended. Neligan prescribed this in large doses; even an *ounce* at once, with mucilage and an aromatic. This is a very bold use of it; but it is said that it acts generally safely as a cathartic in such doses. Ammonio-ferric alum, tincture of chloride of iron, tannic and gallic acids, etc., are used as styptic medicines in some cases. Sponging the body with alum and brandy, or whisky, and water, at such temperature as is not chilling and yet is sedative to the circulation, will be the best local measure.

Neuroses.

Under this head, of affections involving the innervation of the skin, we class *Prurigo*, *Anæsthesia*, and *Neuralgia cutis*.

Prurigo.—Often placed under *papulæ*, because minute pimples occur with it—the essence of this disease is, intense itching without eruption. It is commonly divided into prurigo *mitis*, *formicans*, and *senilis*. *Pruritus* is the technical name for itching as a symptom.

The difference between the first two varieties is one of degree. In the *mitis*, obstinacy rather than severity exists. In p. *formicans*, suffering may be extreme, pervading the body Heat of a fire or of a bed, rubbing of the clothes, etc., may cause an irritation which drives the patient to rub and tear the skin, yet without relief. Sleep may thus be prevented, and the bodily as well as mental exhaustion so produced may be great. The complaint is occasionally intermittent. Very often it is confined to one or two portions of the body; as the scrotum, vulva, anus (pruritus *scroti*, *vulvæ*, *ani*, vel *podicis*), etc. Pruritus *ani* is often caused by worms; especially ascarides.

Prurigo senilis is so named because of its frequency in old people. Lice cause it not unfrequently. Papulæ attend it more often than the other forms.

TREATMENT.—This is sometimes a very hard disease to cure, or even relieve. We must consider and treat the general condition of the body; see that the bowels are regular, the digestion

normal, the skin kept clean and open by ablutions and proper change of clothing. Sometimes nervine tonics may be required; as nux vomica, arsenic, or quinine, in small doses. Tincture of aconite is prescribed by some; three or four drops at a time twice or thrice daily. Conium, belladonna, and other narcotics have been advised. The *hypodermic injection of morphia* may be resorted to to give rest in very distressing cases.

Locally, many things may, and should, be tried in succession, in the search for palliatives. Baths of flaxseed tea, with or without carbonate of sodium or of potassium; lathering with castile soap, with a shaving brush; strong salt water, or whisky and salt; dilute sulphuric, nitric, acetic, or carbolic acid, mercurial ointment, etc.; these are only a few of the measures which may be resorted to. The diet should be unstimulating. Advice should be given to the patient also to refrain as much as possible from violence in rubbing or scratching the parts affected; and not to sleep in a very warm room or under too much cover.

Anæsthesia cutis is only a symptom of a larger affection—involving either the nervous system or the skin itself. It appears in one variety of elephantiasis Græcorum, called by some *lepra anæsthetica.* Vitiligo also is often attended by it, at the parts which undergo discoloration. Except stimulating frictions, when not contra-indicated by the other conditions of the case, and galvanism (faradization), under the same limitations, we have no special remedies to mention for loss of sensibility in the skin.

Neuralgia of the skin, temporarily, at least, limited to it, does undoubtedly occur, though seldom. Its locality does not, however, so remove it from other forms of neuralgia as to require for it a special consideration.

Parasiticæ.

Dermatologists are not all agreed upon the question, whether the *microphytes* or *epiphytes* (minute parasitic vegetations) discovered by aid of the microscope, in connection with certain skin diseases, are *essential* to these diseases, or accidental and secondary only. Wilson even denies their vegetative nature; asserting them to be results of spontaneous granular degeneration of epithelium. Most authorities hold the opinion (especially proved by the results of *treatment*) that the parasites are really the essential *causes* of the disorders they constantly attend; that they may, under favorable circumstances, be *transplanted;* and that, to cure those disorders, destruction of the parasitic forms is necessary. Again, Hebra, a high European authority, believes that all epiphytes described are merely modifications of one and the same species, in different degrees of development. Tilbury Fox agrees with this opinion. E. Hallier[1] makes three series (Mucor, Achorion, Leptothryx) of forms, all capable of being educed from the same spores under different circumstances. Devergie believes in *spontaneous generation* of the epiphytes, although truly vegetable. Dr. McCall Anderson[2] gives proofs, by separate inoculation, of the non-identity

[1] Archiv für Mikroscopische Anatomie, April, 1866.
[2] Brit. and For. Medico-Chirurg. Rev., July, 1866, p. 225.

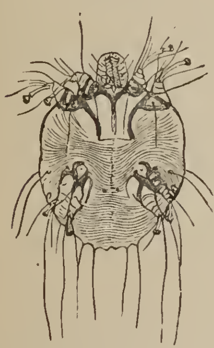
of *three* vegetative parasites at least—*trichophyton*, *achorion*, and *microsporon*.

No doubt exists with the large majority of observers as to the cause of the animal parasitic eruption, *scabies* or itch.

Scabies.—Chiefly vesicular, this disease may be papular, scaly, or pustular in some instances. Ordinarily we see, especially between the fingers and on the back of the hand, next often on the arms, legs, and abdomen, occasionally on the scalp, hardly ever on the face—a number of small red elevations with white or watery tops. Extreme itching is always present; often keeping the individual scratching night and day.

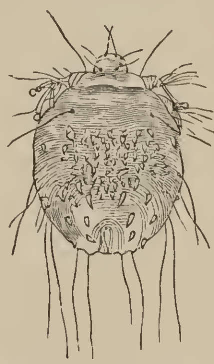
Closely looking at almost any of the vesicles, one may see a little red line or track, at the end of which may be found a slightly elevated point. In this is, generally, the animalcule—*Sarcoptes hominis* (Acarus scabiei); one of the *Arachnida*—flat-bellied, round-backed, tortoise-shaped, eight-legged; the female larger than the male, which is hard to find.

Fig. 316.



ITCH ANIMALCULE, UNDER SURFACE.

Fig. 317.



MALE SARCOPTES, UPPER SURFACE.

TREATMENT.—Sulphur is, not the only, but the most reliable and convenient parasiticide for itch. After thorough bathing, and washing of the whole body with soap and water, strong sulphur ointment must be rubbed well into the parts affected. A few applications will usually suffice. The animalcule is killed, and the cure follows. There is evidence, however, that in some cases of long standing, recovery may follow but very slowly. The *habit* of the eruption has then become established in the skin; this must be treated like eczema, or lichen, whichever it most resembles.

Oil of turpentine, kerosene, or petroleum, ointment of sulphuric acid, and other powerful agents, may be also confidently relied upon to destroy the itch animalcule.

Army-Itch.—During and since the late war in this country, the inevitable filth of camp-life begot, among other evils, a very

troublesome contagious skin-disease, called by the above name. Itching, without any eruption except small papulæ, characterizes it. Outside of the army it has extended to a considerable number of persons. No better remedy for this affection has been found than a lotion and ointment, composed of iodide of potassium and glycerin; with water or rose-water for the lotion, and lard or cold cream for the ointment. Mercurial ointment, and sulphuric acid ointment, are also efficacious for it.

The other parasitic affections of the skin depend upon the microphytes already alluded to. They are *Favus*, *Sycosis*, *Tinea circinatus*, *Tinea decalvans*, *Chloasma versicolor*, and *Plica Polonica*.

Favus. (*Porrigo*, *Tinea favosa.*)—Generally appearing on the scalp, this disease is peculiar in the formation of yellow cup-shaped crusts, in each of which one or two hairs may grow. By joining together, these crusts may lose their regularity of shape, in a general scabbing; and a good deal of hair may fall out. A mealy powder is found in the crusts, which, on microscopic examination, is found to contain the formation called *achorion Schönleinii* by Remak. This presents minute tortuous branching tubes, straight or crooked not branching tubes, and sporules, free or united in bead-like strings. Granules and cellules of *mycelium*, the generative portion of the plant, are abundant. An offensive discharge occurs from the eruption in bad cases.

Favus is contagious, though seldom conveyed to cleanly persons. It is hard to cure, but not incurable. In its treatment, constitutional and local measures must be combined. Arsenic is the most reliable alterative. Neligan has advised the iodide of arsenic, gr. $\frac{1}{12}$ thrice daily; intermitted if headache or dryness of the mouth come on.

For the local treatment, the hair must be *closely cut* with sharp scissors. Apply then a large flaxseed poultice for twelve hours or more, perhaps repeatedly, to soften the crusts. Next, wash the head thoroughly, by means of a soft sponge, with solution of carbonate of potassium (one drachm to a pint of water) after which ointment of carbonate of potassium (potass. carb. ʒj, glycerin fʒj, adipis ℥j) may be applied spread thickly on lint, covered with oiled silk. This may be renewed daily; or, if there be much discharge, twice a day. The crusts then come away in a few days. Ointment of iodide of lead may follow; washing the head night and morning, still with the carbonate of potassium lotion; and keeping the hair cropped short all the time. Three or four weeks will generally suffice for a cure. Cleanliness of person and regulated diet are at the same time, of course, essential.

For this and other parasitic affections of the skin, *tar ointment* is a far from contemptible remedy.

Sycosis (*Mentagra*).—This occurs on the bearded part of the face, chiefly the chin. It is contagious; sometimes being transmitted by uncleanly barbers in shaving. It presents slightly inflamed elevations about the roots of the hairs, covered by scurf; shaving decapitates these, inducing irritation and suppuration, as well as scabbing. The whole chin may become swollen and inflamed by it; and parts of the beard may be destroyed. The parasitic cause of this disease is the *trichophyton mentagrophytes*

(*microsporon mentagrophytes* of Gruby). It is seen under the microscope to consist of minute stems, bifurcated at angles of from 40° to 80°, and granulated within.

Sycosis is not common. Acne, impetigo, and ecthyma of the bearded part of the face may be confounded with it. It is very hard to cure. In its treatment, keeping the beard constantly very short by close clipping (not shaving) is essential. Sponging twice daily with castile soap and water, or carbonate of potassium lotion, will be beneficial. Iodide of lead ointment, ointment of nitrate of mercury, and of calomel and camphor, etc., may be used in succession; besides the internal use of arsenic.

Tinea circinatus (*Ring-worm, Scald-head*).—This is known by its circular form, occurring most often, though far from always, on the head or face. *Herpes circinatus* resembles it; but in that minute vesicles are usual; in *tinea*, rare and few. In *tinea* a thin powdery crust exists, whose examination will show the *trichophyton tonsurans*, closely allied to the parasite of sycosis.

Tinea decalvans is marked by a destruction of the hair in circular patches, making round spots of baldness. Its parasite is considered by many dermatologists as different from the *trichophyton*, and called *microsporon Audouinii*. Its sporules are rounder and smaller than those of trichophyton.

The TREATMENT of both forms of tinea must be, besides cleansing, essentially *paraciticide*. Tar ointment; "huile de cade;" mercurial ointment; solution of corrosive sublimate; lotion and ointment of carbonate of potassium; lotion of sulphurous acid; carbolic acid; creasote; cantharidal collodion, lightly applied: these are among the many applications which may be used for the purpose, with generally successful result.

As has been observed, tinea is seldom transmitted to a cleanly person; at least without very close and continued contact.

Chloasma versicolor (*Pityriasis versicolor*).—The parasite of this is *microsporon furfur*. The disease is recognized by the formation of dull, reddish-yellow spots of various size and shape, seldom numerous, on the front of the chest or abdomen. The same local applications may be used for it as for tinea; besides the internal use of arsenic.

Plica Polonica.—This is an affection of the hairy scalp, endemic in Poland, Russia, and Tartary. The hair-follicles become diseased, and the hair is matted and glued together into felt-like masses. *Trichophyton tonsurans* and *trichophyton sporuloides* are the parasitic vegetations described as found connected with it. The disease has not been seen in this country.

Syphilida.

Enough for our purpose and space has already been said of the general history of syphilis. Among its constitutional manifestations, cutaneous eruptions are very frequent. These are seldom vesicular, not very often papular; most often squamous or scabbing. Lepra and rupia, particularly the latter, are prominent among syphilitic affections, though both may occur independently of syphilis. All eruptions in persons of this diathesis are marked

by a *coppery color*, which remains long, even after their cure; by a disposition to ulcerate, perhaps only superficially; and by preference in locality for the face, shoulders, and back.

In the TREATMENT of syphilitic eruptions, the diathesis must be met by our remedies. Iodide of mercury internally; after that iodide of potassium, and, in feeble persons, cod-liver oil, perhaps iodide of iron; locally, mercurial ointment (besides palliatives, if required, as in other eruptions), or the calomel vapor bath, should be prescribed. Often, such affections will seem to be cured, but, after weeks or months, will return again; then the treatment should be renewed, and discontinued when they disappear.

CHAPTER XI.

HEMORRHAGES.

VARIETIES.—1. Active; 2. Passive; 3. Traumatic; 4. Symptomatic; 5. Critical; 6. Vicarious. Local hemorrhages are also classified according to the organs from which the blood escapes.

Active hemorrhages are those in which determination of blood in excess to the part precedes the bleeding.

Passive hemorrhages, those in which, from inaction of the circulation, or passive dilatation of bloodvessels, congestion occurs; or in which the coats of the vessels give way too readily, partly from the blood itself being incapable of maintaining properly their nutrition. The idea of bleeding by "exhalation" without rupture at least of capillaries, is now generally abandoned.

Traumatic hemorrhages are, of course, all produced by wounds; coming thus under the department of surgery.

Symptomatic hemorrhages are met with in many diseases; *e. g.*, epistaxis in typhoid fever; hæmoptysis in consumption; vomiting of blood in cancer of the stomach; bleeding from the bowels in piles, etc.

Critical hemorrhages are occasional terminations of febrile disorders; as of yellow fever, remittent fever.

Vicarious hemorrhage is that which substitutes one which is normal or habitual; *e. g.*, spitting of blood when the menses have been suppressed; or bleeding at the nose following arrest of the bleeding of habitual hæmorrhoids.

Epistaxis.—By usage this term is applied only to bleeding from the nose. In young persons, especially from ten to fifteen years of age, it is common, and, if moderate, harmless; seeming often to relieve a temporary congestion and prevent a headache. It is more often seriously troublesome in older persons. Generally it is from one nostril only, but not always.

TREATMENT.—When slight, it may be allowed to stop of itself; only not blowing away the clot that forms as a natural plug. If

it continue so as to threaten an injurious loss of blood, applying cold water to the forehead and nose, or *ice*, there or to the back of the neck, or the roof of the mouth, will generally stop it. If not, a plug of dry cotton may be introduced and left in the bleeding nostril. Wetting the cotton first in strong alum-water, or dilute tincture of chloride of iron, or dipping it in powder of tannin or matico may make it more effective. When these measures fail, the posterior nares must be plugged. Either the watch-spring canula may be used, or an elastic catheter, having a piece of waxed ligature or twine passed through its eyelet hole, may be carried back from the nostril to the pharynx. Then the string should be drawn out of the mouth with forceps, a plug of cotton should be fastened to it, and drawn by means of the catheter till it forces the cotton plug against the posterior orifice of the nares. Raising the arms high above the head is a popular mode of endeavoring to stop nose-bleeding.

Bleeding from the Mouth.—This, unless when ulcerative, is generally from the gums; as in scurvy. It is, in itself, scarcely ever serious in amount. Considerable bleeding, sometimes hard to stop, may occasionally follow the extraction of a tooth.

TREATMENT.—Borax in solution, or tannic acid, or myrrh and rose-water, will be suitable washes for the bleeding and spongy gums of scurvy. For hemorrhage after the removal of a tooth, it may be necessary to plug the cavity with lint or cotton dipped in tincture of chloride of iron, or creasote.

Hæmoptysis.—This term (spitting of blood) is generally applied to hemorrhage from the lungs, bronchial tubes, trachea, or larynx. Ulceration of the larynx, trachea, or bronchi may produce it, not often dangerously. More often the source of the blood is the lungs. The diagnosis of this is of great consequence. Between pulmonary hemorrhage and that from the stomach, the following contrast of signs exist:—

From the Lungs.	*From the Stomach.*
Dyspnœa.	Nausea.
Blood coughed up.	Blood vomited.
" florid, sometimes frothy.	" dark, not frothy.
" mixed with sputa.	" mixed with food.

In a majority of instances, spitting of blood from the lungs is a symptoms of phthisis. Cases occur, however, sometimes, especially during adolescence and early maturity (from 18 to 30 years of age) of more or less active pulmonary hemorrhage, whose subsequent history disproves a tuberculous origin for it. In these cases, there may be immediate danger, more probably than in the frequent bleedings of consumption. Aneurism of the aorta may also cause hæmoptysis, by rupture of the tumor, which must cause death. This of course is rare, and is made known by signs already considered.

TREATMENT.—For active congestive pulmonary hemorrhage, in a young and robust person, it was formerly the common practice to take blood from the arm, as a *derivant* measure. But, dry cup-

ping over the chest and back, with sinapisms to the legs, and ice, salt, or alum, swallowed slowly, the patient being at perfect rest in bed, with the head and shoulders raised, will be sufficient treatment at the start for most cases. Then we should prescribe, if the bleeding continue after the first gush, acetate of lead with opium in pill; say a grain or two of the former with half a grain of the latter every four, three, or two hours as the case needs, for a day or two.

In passive, or tuberculous hæmoptysis, rest, with the head and shoulders propped, is also necessary. Ice, salt, and alum, alone or together, may be held in the mouth and swallowed very slowly, till the bleeding has stopped for the time. For medicines, in the anæmic, gallic acid (gr. x to gr. xxx, in solution with aromatic sulphuric acid), oil of turpentine (gtt. x to gtt. xx, in mucilage), and ammonio-ferric alum (gr. v to gr. x), or tincture of chloride of iron, are most recommended. But dosing with these styptics in consumption is not proper for every trifling discharge of blood. They are suitable only when the hemorrhage itself is, or threatens to be a source of additional debility.

Pulmonary Apoplexy.—This is the extremest degree or result of congestion of the lungs; hemorrhage occurring into the air-cells, and obstructing respiration, sometimes to a fatal degree. Disease of the heart predisposes to this. Its attack is apt to be somewhat sudden; there is great dyspnœa, with a purple countenance, and skin rather cold. Percussion resonance is dull. On auscultation, at first, a bubbling or mucous râle is heard; after the blood coagulates, no respiratory sound at all.

TREATMENT.—If diagnosticated early, in a person of tolerable strength, venesection may be performed at once. Then (or instead, in a feebler subject) dry or cut cups should be applied extensively between the shoulders; followed by a large sinapism over the anterior part of the chest, and a hot pediluvium. At the same time the reaction which should aid in unloading the oppressed lungs (the object of venesection, cupping, etc.) may need to be favored by hot drinks, as hot lemonade, carbonate of ammonium, or if coldness be decided, whisky punch.

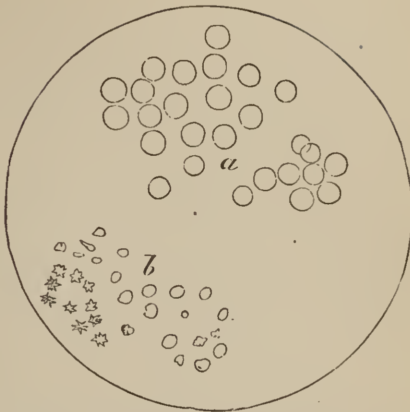
Hæmatemesis.—Vomiting of blood may result from cancer, or ulcer of the stomach, congestion of the liver, aneurism of the abdominal aorta, etc. We have given, above, the distinguishing signs between it and hæmoptysis.

TREATMENT.—Of course this must be varied according to the cause. Slight ejections of blood from the stomach may not of themselves require treatment—having only a diagnostic importance. In ulcer of the stomach the greatest danger may occur, except from rupture of an aneurism. In copious hæmatemesis, with absolute rest in the horizontal position, ice, creasote (one or two drops, *pro re nata*), in solution or pills, gallic acid, oil of turpentine, ammonio-ferric alum, or tincture of chloride of iron, may be prescribed. Food must be given in small quantities, and concentrated,

Hæmaturia.—This may be either from the kidneys or from the bladder. If the blood is thoroughly mixed with the urine, it is probably renal. If the water flows off nearly pure, and the blood

follows or accompanies the last portion, it is vesical. When it follows the use of a catheter or bougie, independently of urination, and flows in a stream or in fresh drops, it is urethral and traumatic.

Fig. 318.



BLOOD CORPUSCLES IN URINE.—*a*. Slightly distended. *b*. Serrated and shrivelled.

Renal hemorrhage may attend congestion or inflammation of the kidney; or cancer; or scarlet fever (generally a late stage); or the irritation of a calculus; or that of cantharides or turpentine; or, in old persons, it may be passive. In Egypt, a parasite sometimes produces it; the *distoma hæmatobium*.

TREATMENT.—For hemorrhage from the kidney sufficient to deplete at all seriously, astringents, as gallic acid, tincture of chloride of iron, alum, or acetate of lead, may be used. Rest is important, in this as in all hemorrhages, during the attack. Bleeding from the bladder may be treated by the injection, through a catheter, of solution of alum or dilute solution of creasote (gtt. j. in f℥j of water) or tannic acid (gr. x in f℥j).

Intestinal Hemorrhage.—The causes of this are, especially, typhoid fever, of which it is sometimes symptomatic, and occasionally critical; *i. e.*, the commencement of convalescence. The same may occur in yellow fever, or in remittent fever (less often). Aneurism of the aorta, congestion of the liver, abdominal cancer, may cause it. Blood is passed, commonly in small quantity, with the discharges of dysentery. Aged persons not unfrequently have passive hemorrhage from the intestines. Internal piles are very often productive of it. The blood from the latter is bright red; other bleeding from the bowels is darker and more mixed.

TREATMENT.—Acetate of lead, by the mouth, with opium, or by enema; tannic or gallic acid, in pill or by injection in solution; oil of turpentine; creasote, and tincture of chloride of iron, or ammonio-ferric alum, are here, as in the other hemorrhages mentioned, the most reliable astringents. For bleeding piles, special treatment has been already alluded to.

Vicarious Hemorrhage.—The most frequent instances of this are in connection with suppressed menstruation. Epistaxis, hæmoptysis, hæmatemesis, renal or intestinal hemorrhage may occur, but it is most apt to be from the stomach or lungs. The PROGNOSIS in this form of hemorrhage is much less serious than in the same of other origin. Its treatment should be addressed mainly to the

regulation of the disturbed or interrupted uterine function. Warmth to the lower extremities and back, with such *emmenagogues* as each case may indicate, will generally be required. Astringents are to be avoided in vicarious hemorrhage, unless it be in excess of the ordinary menstrual or other suppressed discharge.

Uterine Hemorrhage.—Besides simply excessive menstruation, uterine hemorrhage may occur from placenta prævia ("unavoidable hemorrhage"); abortion; subsequent to delivery; uterine cancer; ulceration of the os or cervix uteri; tumors within, or in the walls of, the womb.

TREATMENT.—In considerable uterine hemorrhage, of either variety, ergot, in substance or the wine, is likely to be of use by promoting contraction of the womb. Ammonio-ferric alum is also a good medicine to give by the mouth in the same case. Locally, ice or iced water may be (with care not to chill too much) applied for a short time over the hypogastric region, or thrown into the vagina. Tincture of chloride of iron, in strong solution, will have a powerful effect. Tannic acid or matico may be likewise applied; or the "styptic rod" of tannic acid and cocoa butter, shaped to fill the vagina. But threatening cases (except *post partum*) may require the actual *tampon*, or plug of lint for the whole vagina, or the sponge-tent inserted into the os uteri itself. Stimulants may at times be called for to prevent fatal exhaustion under hemorrhage, either from the uterus or from any other organ. Pressure upon the aorta has been sometimes resorted to, through the abdominal walls, in uterine hemorrhage. Other measures, suitable after delivery, belong to the department of obstetrics.

Habitually excessive menstruation requires that the patient so affected should maintain absolute rest, from the beginning of the flow till its cessation. Iron is nearly always indicated in such cases, through the interval; particularly the tincture of the chloride of iron, or ammonio-ferric alum.

CHAPTER XII.

DROPSICAL AFFECTIONS.

VARIETIES.—1. *Œdema*, local infiltration of connective tissue with serum. 2. *Anasarca*, general cellular dropsy. 3. *Hydrocephalus*. 4. *Hydrothorax*. 5. *Hydropericardium*. 6. *Ascites*. 7. Other local dropsies; as *Ovarian* dropsy, *Hydronephrosis*, *Hydrocele* of the testis, etc.

CAUSATION AND PATHOLOGY.—Obstruction to the venous circulation, arrest of excretion and absorption, and excess of water in the blood, are the three cardinal elements of the pathological causation of dropsy. Either one may induce it. Disease of the heart or of the liver brings on dropsy by venous obstruction. Disease of the kidney, or the action of cold and wet upon the skin, may produce it by checking excretion. Wasting diseases are liable

in their advanced stages to œdema and anasarca, on account of the watery state of the blood.

Acute general dropsy results from the powerful impression of cold and wet, or of the scarlet fever poison, upon the system; suppressing both the action of the kidneys and that of the skin at once. Its most common form is anasarca; but it may take that of ascites, hydrothorax, or even hydrocephalus. When from cold and wet, it is much more curable (especially anasarca or ascites) than similar dropsy of *visceral* origin, *e. g.*, from disease of the heart. Albuminous urine is quite common in acute general dropsy.

Hydrocephalus, *hydropericardium*, and *hydrothorax* have been already sufficiently considered.

Ascites; peritoneal dropsy; accumulation of water in the abdomen. The CAUSES of this of greatest frequency are, cirrhosis of the liver, and disease of the kidney. It may also follow obstruction of the portal vein by cancer, or general obstruction of the circulation from disease of the heart, aorta, or spleen; and it is sometimes ascribed to chronic peritonitis.

SYMPTOMS AND DIAGNOSIS.—Often with emaciation of the face, neck, and arms, there is great enlargement of the abdomen. When this is far advanced, *orthopnœa* exists, from pressure upon the diaphragm. The patient is generally weak, with poor appetite and deficient rest at night.

On *inspection*, in the upright posture, the fulness is greatest in the lower part of the abdomen; when recumbent, it spreads evenly; on one side, it falls over that way. *Palpation* will make evident *fluctuation*, especially when one hand is placed on one side of the abdomen and the other strikes gently, at a distance of a few inches. *Percussion* discovers resonance above and about the umbilicus, the intestines rising there upon the fluid to the surface under the abdominal walls. Elsewhere, the sound is dull, even flat.

The amount of fluid in ascites is sometimes immense; as much as twenty-five pints have been withdrawn at once by tapping. It is generally clear, pale yellow or colorless, albuminous and alkaline.

Ovarian Dropsy.—Leaving the history of this, as belonging to the special department of diseases of women, it is right to state that its diagnosis is important, but not always easy. Like ascites, it produces abominal enlargement, with dulness on percussion and fluctuation. The most nearly constant points of distinction are, that the ovarian tumor begins somewhat on one side, and only by degrees becomes symmetrical; its shape is, throughout, more globular and coherent, and altered less by changes of position; and the intestines do not float up above the umbilicus so as to make a clearness of percussion-resonance there. The progress of ovarian dropsy is usually slower, and attended by less proportionate depression of the general health.

TREATMENT OF DROPSY.—Acute general dropsy, from suppression of the action of the skin and kidneys, should be treated by active purgation and the use of diuretics. Jalap and cream of tartar (gr. x of the former with ʒij to ʒiv of the latter) every day or two, will answer well for catharsis. The diuretics most satisfactory are the infusion of juniper berries (a pint daily), acetate

of potassium, citrate of potassium, squills, and sweet spirits of nitre. When the patient is hard to purge, elaterium may be given, in gr. $\frac{1}{4}$th doses, every four hours till it operates.

Ascites, or other dropsy, from disease of any of the great organs, kidneys, liver, or heart, being less curable, and attended by greater general debility, needs more economy of strength. No doubt exists that real harm may be done by the routine of severe purging and plying with diuretics. The one may render the blood thinner and aggravate the constitutional disease, while the other, failing to remove the fluid by secretion, may even irritate the kidneys to the point of suppression of their action. Nourishing concentrated food, tonics, anodynes, etc., may, in visceral dropsy, be of more importance than diuretics. Of course it is desirable to lessen the accumulation of fluid; but the effects of the remedies used must be observed, and one symptom must not be allowed to overshadow all the rest.

When enormous distension makes rest impossible, and almost prevents breathing, it is necessary to relieve it by any possible means. Then, purging, as, by elaterium, should diuretics fail, must be resorted to. Or, if the patient's stomach or general strength will not bear that, *paracentesis*, tapping, is called for. Some patients require this many times.

The operation is best performed while the patient is lying down upon the side, near the edge of the bed. A trocar and canula are introduced half-way between the pubes and the umbilicus, and the fluid is drawn out through the canula. Then a bandage (with a compress) is applied firmly around the abdomen. Some practitioners favor keeping open the orifice with a slip of lint, to maintain drainage. If no local irritation occur, threatening peritonitis in consequence, this may be a serviceable measure. If the bolder practice of injecting iodine after tapping (as in hydrocele) should be thought of in any instance, it must be in the case of simple peritoneal dropsy, uncomplicated by serious visceral disease.

Sometimes œdema of the lower limbs and scrotum becomes so great as to cause great inconvenience. Then the fluid may be let out by making a number of small punctures with an abscess lancet or small pointed bistoury. The only drawback to this is the possibility of erysipelatous inflammation about the punctures. Such danger will not be at all great if, immediately after the operation, the parts be soothed by bathing or anointing the skin with diluted glycerin (f ʒj in f ℥j of rose-water), or cold cream (ung. aq. ros.), or glyceramyl (glycerin and starch).

For the treatment of ovarian dropsy, the reader is referred to SURGERY.

CHAPTER XIII.

WORMS.—ENTOZOA.

Helminthology, the study of worms, has assumed of late a very considerable importance in connection with medicine. About thirty entozoa inhabit different parts of the body of man. They have been generally classified as *Cœlelmintha*, or hollow worms, and *Sterelmintha*, or solid worms, *i. e.*, without any well-defined alimentary cavity. Broad or flat worms, *Platelmia*, and thread-like or cord-shaped worms, *Nematelmia*, constitute another arrangement. Of the flat worms, some are *Cestoid*, or ribbon-like; others *Trematode*, or fluke-like. The most important ones are enumerated in the following table:—

Cestoid Worms:

Mature: Tænia solium; Tænia echinococcus;
Tænia mediocanellata; Bothriocephalus latus.

Immature: Cysticercus cellulosæ; Cysticercus t. mediocanellatæ.
Echinococcus hominis.

Trematode Worms:

Distoma hepaticum (fasciola hepatica). Bilharzia hæmatobia.
Distoma ophthalmobium. Tetrastoma renale.

Nematoid Worms:

Ascaris lumbricoides. Sclerostoma duodenale.
Trichocephalus dispar. Filaria medinensis.
Oxyuris (ascaris) vermicularis. Strongylus gigas.
Trichina spiralis.

Tænia solium and *tænia mediocanellata* look a good deal alike; but the former is much smaller. The immature *cysticercus* of the former is $\frac{3}{16}$ of an inch long; that of the latter, of the size of a pea. The *t. solium* has a circle of hooklets around a convexity of the head; the *mediocanellata* is club-headed, with larger sucking disks than the *solium* has. One is designated as "armed" and the other "unarmed" tapeworm. The former (*t. solium*) is from the *cysticercus cellulosæ* of the hog; the latter from the "*cysticercus bovis*"[1] (Cobbold); and is the most common. The unarmed is the easiest to drive out.

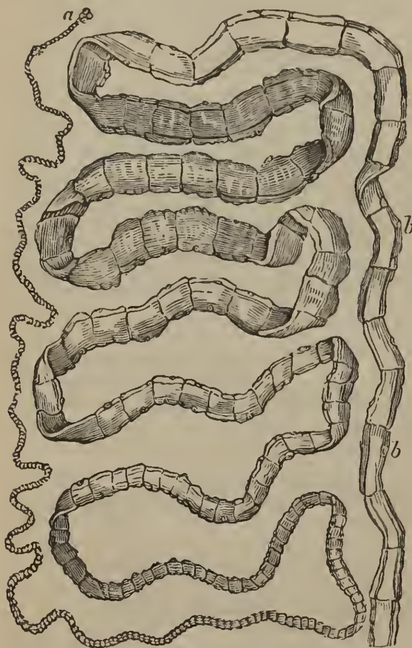
The tapeworm is formed of flat segments, often several hundred in number, connected with the head by a slender neck. Each segment has male and female organs (hermaphrodite); as those at the tail mature, they are cast off. Some patients thus pass six or

[1] Cobbold states that the *hydatid* of the cysticercus bovis has never yet been observed in man. Hydatid or "echinococcus" disease is especially frequent in Iceland.

eight fragments from the bowels in a day. The whole length of the parasite is from ten to thirty feet.

The SYMPTOMS caused by tapeworm are not very determinate. They resemble those produced by other worms; namely, uneasy sensation in the abdomen, and general nervous irritation; bad sleep, attacks of *faintness*, and lowness of spirits, indigestion, irregularity of appetite and of the acti n of the bowels; itching of the nose, and sometimes of the anus. Epilepsy and insanity are said to have sometimes been caused by it. The only *proof* of tapeworm is the finding of fragments of it in the stools. It is a common impression that it is never destroyed unless the head is discoverable; but this is not exactly true. Conversely, if the head comes away, the parasite to which it belongs is no longer reproduced. More than one of them may, however, be present at once; though this is rare.

Fig. 319.



TÆNIA SOLIUM.—*a*. Head. *b*, *b*. Lateral orifices.

The broad tapeworm, *bothriocephalus*, is known only in Northern Central Europe; Russia, Sweden, Norway, Lapland, Finland, Poland, and Switzerland. Its head is elongated, compresssed, obtuse; its length from six to twenty or twenty-five feet. It does not give off detached segments. Cobbold says it is indigenous to Ireland; although he has never met with a patient born in that country who has been the subject of it.

TREATMENT OF TAPEWORM.—*Oil of turpentine*, in half-ounce or ounce doses, will generally purge, and bring away the worm. It *intoxicates* some persons. In Egypt, *petroleum* is used for the same purpose, in doses of twenty or thirty drops. The *ethereal extract* (commonly called oil) *of male fern*, *extractum filicis liquidum*, U. S. Pharm., in the dose of a drachm and a half to two drachms, is esteemed highly by some practitioners. *Koosso*, the flower of the *brayera anthelmintica* of Abyssinia, in half-ounce doses, mixed with water, given on an empty stomach, is almost certain to destroy

or remove the parasite. So is said to be *Kamcela*, the *Rottlera tinctoria* of botanists. Pumpkin seeds, plentifully taken on an empty stomach, are quite effectual.

Prevention of Tapeworm.—As immature tapeworms find residence in the bodies of animals used for food, and thus get the opportunity to enter the human alimentary canal, the *avoidance of raw or under-cooked meat* is the precept of prophylaxis suggested, and confirmed by experience. This applies not only to the prevention of tapeworm, but, also, to that of other parasites, especially *trichinæ.* Tapeworms are derivable from infested beef, even oftener (Cobbold) than from pork. Mutton has been found occasionally to contain cysticerci.

Trematode Worms.

These are the *Distomata*, *Bilharzia hæmatobia*, *Tetrastoma renale*, and others. They are of a flattened oval shape, soft and smooth. They have a bifurcating alimentary canal, with a mouth, but no anus. Both sexes in *distomata* are upon one individual. They exist in two conditions, mature and encysted, and immature and free. Their methods of reproduction are very curious, but of greater importance in zoological than in pathological science.

Distoma hepaticum, found sometimes in the liver and its ducts, measures about an inch in length when mature, and rather less than half an inch in width.

Distoma ophthalmobium has been found in the eye of a child having congenital cataract. It is about half a line ($\frac{1}{24}$ in.) in length.

Bilharzia (or *distoma*) *hæmatobia* is found in great abundance in Egypt; where it inhabits the *veins* of the *abdominal organs* of the inhabitants, in the proportion of nearly one-third of the population. Hemorrhage from the kidney, and the symptoms of dysentery, may follow from its presence. It is not more than three or four lines ($\frac{1}{4}$ to $\frac{1}{3}$ in.) in length. The sexes are on different individuals.

Tetrastoma renale is occasionally found in the substance of the kidney. It is nearly half an inch long.

Nematoid, or Round Worms.

Ascaris lumbricoides is the commonest of entozoa. It inhabits mostly the small intestines; but may get into the stomach, and of course, the large intestines. This round worm is from five to fifteen inches in length, light brown in color, tapering to a point at each end. A considerable number of them may exist together; it is only then that their presence in the bowels is likely to do much harm, unless in very susceptible children. Their escape into the stomach may cause nausea, vomiting, and indigestion, sometimes difficult to account for until the throwing up of the worm explains the cause. These worms probably enter the body chiefly in the drinking water of shallow wells, muddy streams, etc.

TREATMENT; DIAGNOSIS.—Two things are wanted: to expel the worms present, and to prevent their reaccumulation. As to the evidence of the existence of lumbricoid worms in the bowels,

Fig. 320.

Ascaris Lumbricoides. — *a*. Anterior extremity. *b*. Posterior extremity. *d*. Vulva. *e*, *e*. Longitudinal lines.

it is always doubtful unless some of them pass out with the evacuations. Signs of gastro-intestinal and nervous irritation attend them, especially in infants and young children. So, grinding the teeth during sleep, itching of the nose and anus, bad or irregular appetite, and tumidity of the abdomen, are regarded commonly as signs of worms. But other sources of indigestion and disturbance may be thus made known. Convulsions may undoubtedly be caused by worms in children; and so may laryngismus stridulus and spasmodic croup.

When there is good reason to believe that they do exist in the bowels, anthelmintics may be given, with purgatives, in safe doses, watching their effects. Besides the *vermicides* mentioned in connection with tapeworm, many other drugs have more or less of such effect; as santonin (most certain of all), calomel, pinkroot (spigelia), bark of pomegranate root, azedarach, chenopodium, cowhage (mucuna), powder of tin, etc.

Infusion of senna and spigelia, half an ounce of each to a pint; for an adult, a wineglassful every morning before breakfast; this is very popular and often effectual. Instead, may be given *fluid extract of spigelia and senna*, a teaspoonful for a dose. As above said, santonin is the most effectual of the vermicides or vermifuges. It requires care in its use, however; producing serious vomiting, prostration, and nervous symptoms in over-dose. A child should not take more than half a grain of santonin once or twice daily; an adult, from three to six grains.

Trichocephalus dispar.—This worm inhabits the large intestine. It has a length of an inch and a half to two inches. The head is attenuated or hair-like; whence its name. The sexes are on different individuals. The trichocephalus is much less common than the lumbricoid worm.

Oxyuris vermicularis (*Ascaris vermicularis*). *White seat-worm.*—Of this the male is about a line ($\frac{1}{12}$ inch) and a half long; the female, five or six lines. It is found in the rectum, generally of children; sometimes in considerable numbers. They cause a great deal of itching; occasionally, other nervous irritation. Females may have them to find their way into the vagina; more rarely, they get into the urethra.

For the TREATMENT of seat-worms, nothing is equal to *suppositories of santonin;* made with cacao butter, three grains of the drug in each; one to be introduced into the rectum every night. Other common remedies are, injections of lime-water, infusion of aloes, mercurial ointment, etc.

Fig. 321.

OXYURIS VERMICULARIS.—*a.* Head. *b.* Tail. *Natural size.

Trichina spiralis.—Zenker of Dresden first showed that, although a few *trichinæ* may be innocent, they sometimes abound to such an extent as to cause serious disease, and even to destroy life. Such an affection is called trichinous disease, *trichiniasis* or *trichinosis.* It has occurred particularly often in Germany, where it has been recognized since 1860. The first cases in America were reported by Dr. Schnetter of New York. At Marion, Iowa, in 1866, nine cases occurred in one family; five died. In the same county, eating raw ham containing trichinæ (as proved afterwards by examination) caused the disease in six children at once. An examination of pork in Chicago by a committee of the Academy of Sciences of that city proved the existence of trichinæ in 1 in 50 of the hogs inspected; some of their muscles containing from 10,000 to 18,000 in a cubic inch. Such animals are not themselves nearly always out of health. Cattle, also, are, to a less degree, subject to the same parasite. The meat of those so infected should of course not be used for food. In some German cities the butchers have microscropic examination made of the flesh of all their animals.

To the naked eye, the muscles of a trichinous animal present whitish dots, which a lens will show to be the capsules or cysts of immature trichinæ. Those not encysted are invisible without a microscope. The capsule is hard and transparent; the worm is coiled spirally within it. Under the tongue is the preferred place to search for the trichinæ in the living animal; a delicate *harpoon* being used.

The trichina is a minute bi-sexual worm, reproducing in the intestinal canal of animals or men; the offspring then finding their way out through the walls of the intestines to become finally encysted in the muscles. The disease produced by them has two distinct stages: 1, that of the presence of the worms in the alimentary canal, and their multiplication there; 2, that of their migration to and location in the muscles. Of the first period, *malaise*, vomiting, and diarrhœa are the leading symptoms. Of the second, fever resembling typhoid, severe pains, with stiffness in the muscles, and prostration. As the muscles of the larynx are often attacked, hoarseness is a common symptom. The complication of pneumonia is not infrequent. The first stage above mentioned lasts about a week or less; the second may terminate fatally

within six days, but usually has a duration of from two to four or five weeks.

We are not informed of any success with the TREATMENT of trichiniasis. Its PREVENTION is always possible. Besides proper inspection of animals, every piece of meat which may be suspected must be *well cooked.* Reliance cannot be had upon salting and smoking; at least unless they be very thoroughly done.

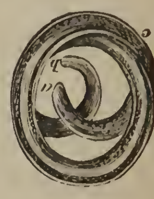
Fig. 322.

CYSTS OF TRICHINA, natural size.

Fig. 323.

ENCYSTED TRICHINA, magnified.

Fig. 324.



TRICHINA MAGNIFIED. *a.* Head. *b.* Tail. *c.* Body.

Sclerostoma duodenale is common in Egypt and in parts of Europe. It exists in the small intestines, and causes a chlorosis-like anæmia. The worm is from a third to half an inch long. Its *vermicide* is said to be turpentine.

Strongylus gigas (*Eustrongylus gigas*) inhabits the kidney. It is rare in man.

Filaria medinensis (*Dracunculus*) or guinea-worm lives in the subcutaneous tissue. It is common in the tropical regions of the old world. The female worm it is, that enters the skin of a human being, and develops, with its contained young, in a whipcord-like shape, to a length varying from six inches to four, five, or six feet, and a width of about one-twelfth of an inch. A dozen or more of the worms may exist upon the same person. The lower limbs are especially invaded by them; but they can migrate almost all over the body. They evidently get into the legs and feet of those who bathe in shallow streams or ponds, or walk barefooted in damp and muddy places. An incubation of a year or more is required for the development of the worm to a perceptible size.

A characteristic vesicle appears, generally upon the lower part of the leg, when the worm matures. This bursts, emitting the young filariæ; a good deal of itching and irritation ensues, and sometimes ulceration. The natives often rid themselves of the worm by letting a stream of water run or pour for a time upon the leg. When it creeps partly out, they draw upon it until it is dislodged.

CHAPTER XIV.

TEMPERATURE IN DISEASE.

The axilla is generally the best place for examination of temperature. The thermometer should be kept there from three to five minutes at a time. Normally, in the armpit, the temperature averages 98.4° to 98.5° Fahr.; with a range in health from 99° to 97.92°. It is about 1° higher in tropical than in temperate climates. It is one or two degrees higher in children than in adults.

A rise of temperature, in disease, of 1° Fahr. corresponds, as a rule, with an increase of the pulse of eight to ten beats per minute. It has been found highest (up to 108° or 112°) in scarlet fever, yellow fever, tetanus, and sunstroke.

In intermittent fever, during the paroxysm, even when the patient shivers and feels cold to himself, his heat by the thermometer is always above the natural degree.

"When the temperature is increased beyond 98.5° it merely shows that the individual is ill; when it is raised as high as 101°–105°, the febrile phenomena are severe; if above 105°, the patient is in imminent danger; with 108° or 109°, a fatal issue may without doubt be expected in a comparatively short time.

A person, yesterday healthy, who exhibits this morning a temperature above 104° Fahr., is almost certainly the subject of an attack of ephemeral fever or of ague; should the temperature rise to or beyond 106.3°, the case will certainly turn out one of some form of malarious fever. It cannot be typhoid fever.

A patient whose temperature rises during the first day of illness up to 105° or 106° Fahr., certainly does not suffer from typhus or typhoid fever. In a patient who exhibits the general typical signs of pneumonia, but whose temperature never reaches 101.7° Fahr., it may be concluded that no soft infiltrating exudation is present in the lung.

If a patient suffer from measles, and retains a high temperature after the eruption has faded, it may be concluded that some complicating disturbance is present.

In typhoid fever a temperature which does not exceed any evening 103.5° indicates a probably mild course of the fever. 105° in the evening, or 104° in the morning, shows danger, in the third week. In pneumonia, a temperature of 104° and upwards indicates a severe attack. In acute rheumatism a temperature of 104° is always an alarming symptom, foreboding danger, or some complication such as pericardial inflammation. In jaundice, otherwise mild, a rise of temperature indicates a pernicious turn. In a puerperal female an increase of temperature shows approaching pelvic inflammation. In tuberculosis an increase of tempera-

ture shows that the disease is advancing, or that untoward complications are setting in.

A fever temperature of 104° to 105° Fahr., in any disease, indicates that its progress is not checked, and complications may still occur."[1]

Certain diseases have been found to have *typical* ranges or daily fluctuations of temperature throughout their course; so that their "differential diagnosis" may be thus assisted materially. This has now been determined, especially in malarious fever, typhus, typhoid, smallpox, scarlatina, measles, rheumatism, pyæmia, pneumonia, and acute tuberculosis. Dr. Da Costa has observed that, in some cases at least, cancer is attended by lowering of temperature. This is marked in the collapse of cholera.

In continued fevers the temperature is generally less high in the morning than in the evening. Stability of temperature from morning to evening is a good sign; on the other hand, if a high temperature remains stable from evening till the morning, it is a sign that the patient is getting or will get worse.

When the temperature begins to fall from the evening to the morning, it is a sure sign of improvement; but a rise of temperature from the evening till the morning is a sign of his getting worse.

Convalescence from disease does not begin until the normal temperature of the body returns, and maintains itself unchanged through all periods of the day and night.

CHAPTER XV.

INHALATION AND ATOMIZATION.

APART from the "anæsthetics," it cannot be said that great success has ever been obtained in the *cure* of diseases by inhalation. *Palliation* of pulmonary and bronchial or laryngeal irritation, or diminution of excessive expectoration, as by simple vapor of water, tar-vapor, or that of infusion of hops, opium, etc., has been often realized. With other aims and agents, disappointment has generally predominated.

For ordinary inhalation, very simple apparatus will suffice. For instance, a wide-mouthed jar or bottle, with a cork in it; the cork pierced by two glass tubes, one straight, and reaching to near the bottom of the bottle; the other short, and *bent* outside of the cork. The bottle is to be not quite filled with the liquid (more or less heated according to its volatility); the bent tube not reaching its surface, the other conveying air into it from beyond the cork. Even this is not necessary, in the case of liquids used with water, at least. We may employ these by pouring boiling water into a convenient vessel of any kind, the medicament being added to it,

[1] Aitken.

and then, covering the vessel with a towel, holding the mouth and nostrils under the edge of the latter. Hops, in infusion, or stramonium leaves, or laudanum, etc., may thus be used. Of laudanum, *e. g.*, twenty or thirty drops may be put in a pint of water, for very worrying cough. *Smoking* is a primitive method of inhalation. Tobacco, so used, sometimes relieves in asthma ; but cigars of stramonium leaves, or of paper saturated with nitrate of potassium, are more effectual in the paroxysms of the same disorder.

Recently, first by Sales Girons, extremely minute division or *atomization* of liquids, so introduced into the air-passages, has been substituted for inhalation. Under the natural fascination of novelty, and the imposing appearance presented by instrumental appliances, it is quite probable that a degree of enthusiasm has existed about it, more than will be permanent. Still, it is an important addition to our means of treatment of affections of the throat, and perhaps of some of those of the lungs. Referring the reader to special works[1] upon it for details, we must give only the briefest account of atomization or nebulization.

The essential idea of it is, the forcing of a fine jet of liquid against either a solid body, or a strong current of air, so as to convert it at once into diffused spray. Bergson, for instance, employed the tubes used for *odorators*, that is, to spread perfumed liquids in the air. Two glass tubes with minute orifices are fixed at right angles to each other, so that the end of the upright tube is near and opposite to the centre of the orifice of the horizontal tube. The upright tube being immersed in the liquid to be nebulized, air is forcibly blown through the horizontal one. The current of air, so passing over the outlet of the tube communicating with the liquid, rarefies the air in the latter, causing a rise of the liquid in the tube, and its very minute subdivision (atomization, nebulization, pulverization), as it escapes. Silver tubes may be used instead of glass, but are harder to keep clean. Glass ones may be cleaned with muriatic acid solution, aided by a bristle to remove obstructions. The form of the tubes may be varied, so as to allow of their application to any part of the body.

Richardson's spray-producer (designed for local refrigeration) is constructed upon a similar principle. It consists of a graduated bottle, through whose cork passes a double tube ; that is, a tube within a tube. The inner one reaches to near the bottom of the bottle, below, and above to near the extremity of the outer tube. The latter has entering it, above the cork, another tube connected with "hand bellows,"—or, two elastic bags, the one nearest the bottle (protected by silk network) acting as an air-chamber, and the farthest one being compressed by the hand to produce a jet of air into the bottle and tube.

Siegle devised an apparatus for the application of steam-power to atomization. The tubes being arranged upon Bergson's principle, a small boiler is connected with the horizontal one, and in the boiler steam is generated by the heat of a spirit lamp. The jet of steam from the horizontal tube nebulizes the liquid drawn up from the vertical tube immersed in a vessel containing it. Various

[1] See Da Costa, On Inhalation.

modifications of this have been made.[1] Though the steadiness of action of the steam-apparatus is a great advantage, for many purposes the hand-ball atomizer is more available.

For full effectiveness of any method of inhalation, in chronic or subacute cases, the patient must have the instrument at his own house, learn its management, and use it with regularity for a sufficient time. This of course must limit very much the employment of such medication.

The first inhalations should always be short, and with warm water only, to inure the patient to their use. The distance of the mouth from the tubes may vary from six inches to two feet. When prepared for it, one may inhale "medicated spray" for ten minutes at a time; breathing deeply if we wish the liquid to reach the remoter air passages. It should never be done after a hearty meal; and the patient should remain in doors for a while after the operation.

Proof has been obtained that atomized liquids inhaled do, sometimes at least, pass down into the trachea; constantly into the larynx. It is probable, indeed almost certain, that a certain portion may even reach the lungs. As to their application, trial has been and is now being made of this process especially in croup, diphtheria, œdema of the glottis, catarrh, chronic laryngitis, hooping-cough, asthma, pulmonary hemorrhage, and phthisis.

False membrane has been asserted by Küchenmeister, Biermer, Geiger, and others to be dissolved, or at least removed from the throat, by inhalation of hot lime-water. Dr. Geiger's method is to make the patient breathe the vapor arising from hot water poured on unslaked lime.

From Dr. Da Costa's monograph upon inhalation I cite the following conclusions, as indicating the present state of experience upon the subject:—[2]

"That in most acute diseases of the larynx, and still more so in acute disorders of the lungs, the value of inhalations of atomized fluids, save in so far as those of water may tend to relieve the sense of distress, etc., and aid expectoration, is very doubtful; though in some acute affections, as in œdema of the glottis and in croup, medicated inhalations have strong claims to consideration.

"That in certain chronic morbid states of the larynx, particularly those of a catarrhal kind, and in chronic bronchitis, they have proved themselves of great value.

"That in the earlier stages of phthisis, too, they may be of decided advantage, and that at any stage they may be a valuable aid in treating the symptoms of this malady.

"That their influence on such affections as hooping-cough and asthma is not satisfactorily proven.

"That they furnish a decided and unexpected augmentation of our resources in the treatment of pulmonary hemorrhage.

"That they require care in their employ; and that in acute

[1] Gemrig, of Philadelphia, Dr. W. Reed, of Boston, and Codman and Shurtleff, of Boston, furnish improved forms of apparatus for atomization.

[2] Op. citat., p. 40.

affections we should consider whether, as they have to be used frequently to be of service, the patient's strength justifies the disturbance or the annoyance their frequent use may be."

DOSES FOR INHALATION.[1]

Alum	10 to 20 grains.
Tannin	1 to 20 "
Perchloride of iron	$\frac{1}{8}$ to 2 "
Nitrate of silver	1 to 10 "
Sulphate of zinc	1 to 6 "
Chloride of sodium	5 to 20 "
Chlorinated soda	$\frac{1}{2}$ to 1 drachm.
Chlorate of potassium	10 to 20 grains.
Chloride of ammonium	10 to 20 "
Watery extract of opium	$\frac{1}{4}$ to $\frac{1}{2}$ "
Fluid extract of conium	3 to 8 minims.
Fluid extract of hyoscyamus	3 to 10 "
Tincture of cannabis indica	5 to 10 "
Lugol's solution of iodine	2 to 15 "
Fowler's solution of arsenic	1 to 20 "
Tar water	1 to 2 drachms.
Oil of turpentine	1 to 2 minims.

CHAPTER XVI.

HYPODERMIC MEDICATION.

It has been amply proved that hypodermic injection of medicinal substances is ordinarily entirely safe; more rapid, certain, and exact, in proportion to the amount, in its effects than medication by the mouth; that it requires about one-third or one-half the quantity necessary when given by the stomach, and produces less complicated and generally less inconvenient results.

The medicines mostly used in this way are narcotics, sedatives, and nervine tonics. It is in diseases or symptoms affecting the nervous system that the greatest number of successful cases has been reported. Pain, most of all, is speedily conquerable by it. Hunter lays down the indications for it thus:—

"When the immediate and decided effect of the medicine is required.

"When medicines administered by the usual methods fail to do good.

"Where the effect of a medicine is required, and the patient refuses to swallow.

"Where, from irritability of the stomach, or other cause (such as idiosyncrasy, etc.), the patient cannot take the medicine by the stomach."

[1] From Da Costa.

The instrument most approved is a small glass syringe, holding about half a fluidrachm, and graduated for drops or minims, with a tube for puncture, of tempered steel, or of silver with a gold point. The end of the tube must be small and sharp. Graduation of the cylinder is not necessary, as it is easy to measure the amount to be taken up by it. Not much pain is usually produced; but sometimes it is quite severe. If the dose of the medicinal agent be not too large, the only danger (unless in an erysipelatous patient) is of a circumscribed inflammation. Repeated injections should not be made at exactly the same spot. In operating, draw the skin tense with the fore finger and thumb of the left hand, and pass the point of the tube quickly and steadily through it. Then push in, not rapidly, the desired amount of the fluid. Avoid subcutaneous veins; the puncture of one of them may give rise to an excessive action of the medicine. Glycerin is sometimes used as a vehicle instead of water.

The agents most used are salt of morphia, atropia, strychnia, and quinia. For anodyne purposes, Dr. Ruppaner prefers *liquor opii compositus*, of which one hundred drops are equal to a grain of sulphate of morphia. Many use the ordinary solution of morphia (gr. j of morph. sulph. in f℥j) or Magendie's (gr. xvj in f℥j). Doses are as follows:—

Sulphate of morphia	gr. $\frac{1}{8}$—$\frac{1}{2}$
Sulphate of atropia	gr. $\frac{1}{60}$—$\frac{1}{30}$
Muriate of strychnia	gr. $\frac{1}{24}$—$\frac{1}{8}$
Aconitia	gr. $\frac{1}{30}$
Liq. opii compos.	gtt. v—x
Sulphate of quinia	gr. i—iv

Among the diseases in which palliation or relief of suffering is often important by means of this method of treatment are, especially, neuralgia, hysteria, cancer and ulcer of the stomach. A case of the latter affection is recorded in which for weeks or months the patient was only able to retain food upon the stomach after the disposition to vomit had been allayed by a hypodermic injection of morphia.

Curative effect from anodynes so employed has been asserted in cases of delirium tremens, mania, and tetanus; from quinine (two to four grain doses) in intermittent fever.

Tentative use of the same mode of practice is justifiable in cholera, hydrophobia, poisoning (as the injection of morphia for belladonna poisoning, and the converse), violent hooping-cough (atropia), pernicious fever, cerebro-spinal fever, heat-stroke, etc.

That the operation is always without inconvenience to the patient is not true. Not only pain but local inflammation and even suppuration may sometimes be induced. But many patients, suffering painful complaints, have had a hundred or more injections made in different parts of the body, without any disadvantage, and with great relief. Caution is necessary to prevent the *habit* of using hypodermic injections of morphia; which, in some instances, has been known to become as inveterate an indulgence as the habit of taking laudanum or smoking opium.

A MANUAL

OF

SURGERY.

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SURGERY.

GENERAL SURGERY.

CHAPTER I.

INFLAMMATION AND MORBID GROWTHS.

General Surgery includes the history of surgical diseases and injuries, and the measures instituted for their relief.

Special Surgery treats of particular surgical diseases and injuries.

Surgical pathology, surgical injury, etc., are terms of convenience employed to include those conditions having special surgical relations.

Inflammation.

Accompanying local lesions of all kinds, various degrees of turgescence of the bloodvessels occur. Upon the application of an irritant to a living tissue, the vessels supplying the part experimented on first contract; afterward dilating, they become engorged, at the same time the skin being reddened, the temperature elevated, and the functional activity increased. This is known as *determination* (hyperæmia). It is transitory, and passes away by resolution if the irritant cease to act, but runs on to *active congestion* if it continue. In this latter condition the vessels become markedly dilated, and filled with blood corpuscles, in a condition of partial stasis; the color of the skin deepens to a reddish-purple; the affected part acts imperfectly if at all; its use is perverted, and a product (exudation) may be formed in the connective tissue about its vessels.

Passive congestion is that variety of congestion arising without previous determination, since it results either from an atonic condition of the bloodvessels, which prevents them from contracting properly upon their contents, as in debility; or from the position of the affected part offering mechanical obstacles to the flow of blood, as in congestion of the lower extremity from organic disease of the mitral valves of the heart.

Inflammation is the third degree of vascular turgescence. The capillaries here are distended with corpuscles. These aggregate along the sides of the vessels, greatly retarding the local circulation, or entirely preventing it. The watery parts of the blood

and white corpuscles (Cohnheim) may exude through the walls of the vessels into the surrounding parts; or direct rupture may occur, followed by extravasation of blood. The connective tissue, by excessive multiplication of its corpuscles, ceases to form healthy tissue, but elaborates a finely granulated mass, which adheres to the outer coats of the capillaries, about the points where the inflammatory changes are the most active. This product is by some thought to be fibrinous in its nature, and has been called exudation from the belief that it is directly derived from the altered constituents of the blood.

The nature of inflammation is not yet fully understood. Many attempts have been made to define it, but so long as the condition itself is imperfectly known all attempts to properly reduce its features to formulary expression must be futile. Its symptoms, on the other hand, are marked, and as long ago as the time of Celsus were recognized. "Rubor et calor cum tumore et dolore" give the characters by which its presence is determined.

Redness.—This symptom is best seen in inflammation of the skin, where it has generally a purplish tinge; or upon the mucous membrane, when it assumes a scarlet hue. Dependent upon the presence of red blood corpuscles for its production, it is found that where these have the freest access the symptom is best developed. In less vascular tissues, such as the fibrous, the color is expressed in delicate shades of pink, as in sclerotitis; or may be entirely absent, as in inflammation of the arachnoid membrane. It may in part be disguised by the presence of other substances, as in iritis, where from the admixture of pigment cells the color is of a reddish-brown. In subacute inflammation of mucous surfaces, the color may become a pale yellowish-gray, as in chronic laryngitis, or a slate gray, as in chronic diarrhœa.

Swelling is occasioned by dilatation of the vessels, and the consequent distension of the tissues increased by the presence of exuded fluid. It is most marked in loose connective, least so in the dense fibrous tissues. In pleurisy and peritonitis, but little resistance being offered to the effusion, large quantities may accumulate in the cavities of the pleura and peritoneum. Observed externally, inflammatory swelling can be distinguished from œdema by not pitting upon pressure.

Heat is always present in inflammation, though in varying degrees. It is more marked upon the skin than upon mucous membranes, upon superficial than deep-seated structures. Hunter demonstrated that the elevation of temperature in a part remote from the heart is greater than at a point nearer that organ; the increase being in a direct ratio with the distance of the inflamed area from the vascular centre. It is believed that the red corpuscles, present here in increased quantity, carry oxygen in excess to the part, and develop an unusual amount of animal heat. The patient frequently exaggerates the intensity of the symptom, since "nerves measure the sensation and not the degrees of heat." Burning pain and flushes of heat are experienced in some disorders of the nervous system and in chronic structural changes unaccompanied with inflammation.

Pain is caused by the pressure of the altered tissues upon their

nervous filaments. It is, therefore, found in degrees proportionate to the tension in the part. Thus, in conjunctivitis where the laxity is great, there is less pain than in sclerotitis. Varying in character with locality, it is sharp in serous membrane, dull in parenchymatous tissue, gnawing and subject to nocturnal exacerbation in bone, gritty in mucous membrane, throbbing in skin, teeth, etc. It is not always present at the seat of the disease. Pain on the inner side of the knee accompanies coxalgia of that side, pain in the left shoulder, hepatitis; irritation of the glans penis, inflammation at some point of the urinary tract; pain in the loins,orchitis. This should not be confounded with pain from neuralgia, which is apt to be periodic, and without the other characters of inflammation.

Increase of sensibility accompanies inflammation. This is more marked upon the skin, mucous membrane, and organs of sense than elsewhere. Thus an inflamed finger is exquisitely tender, an inflamed eye is morbidly sensitive to the light.

Modification of function is witnessed in the secretion from the mucous follicles. Thus, the discharge in urethritis is not mucous, but a muco-purulent secretion.

The causes of inflammation are predisposing and exciting.

The *predisposing* are plethora, constitutional taint, over-excitation of the part, and certain states of the blood, as in production of boils and carbuncles. To these may be added occupation, age, temperament, and insufficient clothing. One attack of inflammation in an organ predisposes it to a second.

The *exciting* causes are either mechanical, as in fractures, wounds, presence of foreign bodies, tight bandaging; chemical, as acids, alkalies, blisters, acrid vapors, extremes of heat and cold; or specific, as the poisons of syphilis, glanders, smallpox, and decaying animal matter.

Inflammation may terminate by resolution, by suppuration, or by death of the part. When by *resolution*, the symptoms subside and the tissues resume their healthy appearance. This may take place spontaneously — delitescence — as in catarrh; or it may suddenly disappear from one locality to attack a remote organ—metastasis—as in mumps. When by *suppuration*, a fluid called pus is formed in the centre of the inflamed tract. Several theories are entertained with reference to the nature of this product. According to Paget, it results from the breaking down of the unused plastic or lymph corpuscles. Virchow contends that it is due to the transformation either of the epithelial or connective tissue corpuscles. Beale affirms that the "germinal matter," a structureless plastic substance everywhere pervading organized bodies, is supplied at times of suppuration in greater quantities than is needed to evolve the "formed matter" or tissue, the excess escaping as corpuscles in a yellowish fluid. Cohnheim asserts pus corpuscles to be only modified white corpuscles of the blood, which have escaped through the walls of the capillary vessels. Stricker admits this to be one mode of origination of pus corpuscles; but believes (with Virchow) that connective tissue cells, and other cells, of inflamed organs, also become pus-cells; and that the latter themselves multiply or *proliferate*, especially by division.

Pus, in whatever manner it may be formed, is a bland, creamy, slightly glutinous fluid, without odor, but having a salty sweetish taste and alkaline reaction, with a sp. gr. of 1030. It consists of a fluid and globules. The fluid (liquor puris) is identical with the liquor sanguinis of the blood. The globules are roundish masses having an average measurement of $\frac{1}{2500}$th of an inch, filled with darkish molecules which give them a granular appearance. Pus so characterized is *laudable* or *healthy*. It becomes *sanious* when a reddish tinge is given to it, and the corpuscles are more or less broken down. In *ichorous* pus the corpuscles are in a great measure absent, and the liquid is thin, acrid, and either colorless or slightly greenish. The pus of syphilis is termed specific.

Prolonged suppuration from an extensive surface, more especially if it occur upon large open surfaces, induces severe constitutional symptoms. *Hectic fever*, the most prominent of these, is generally initiated by a rigor, followed by a fever of a remittent type. The pulse is quick, small, and compressible; the cheeks flushed, eyes brilliant, tongue clean with red tips and edges; respiration hurried, appetite capricious. The excretory functions are very active; the sweating, particularly at night, profuse and colliquative, and watery evacuations are common. Emaciation in time becomes marked; the mind irritable, though clear. Hectic fever is a serious symptomatic condition, and if the conditions giving rise to it remain unchecked, it continues with increasing severity to end in death.

In diabetes, when there is a constant drain upon the system through the urine, constitutional symptoms may appear which closely resemble hectic.

TREATMENT OF INFLAMMATION.—This is both local and constitutional. The local means are restricted to the removal of the cause; to application of cold or tepid water; and to rest of the part. In some positions, as in an inflamed lymphatic gland, firm, gentle compression is often of value. Of local applications, besides cold water or ice, the most employed are nitrate of silver and iodine. These are particularly useful in acute inflammations of the skin and mucous surfaces. They may act, as they are employed in strong or weak solutions, either as astringents or excitants. *Counter-irritation* may be induced by dry cupping, setons, issues, moxas, blisters, and the actual cautery.

Local bleeding.—This is obtained by wet cupping, leeching, scarification, and incision. The first is applicable to broad surfaces, as the chest and loins.

Leeching is employed where cups could not be applied, as upon the genitals, fingers, etc. The surface to be leeched must be perfectly clean. A little blood on the part, or previous immersion of the leeches in warmish porter or diluted wine, will induce the animals to take hold. They should be dried on a soft towel before application. A loose cambric cloth thrown over them excites them to increased activity. Leeches drop off when engorged, but if it is desired to cause them to loosen their hold before this, a little salt will be found to be efficient. The European draws from ℥ss to ℥j of blood. The American from ʒj to ʒjss. Leechers calculate six of the latter to an ounce of blood. When ordering

depletion by leeches, it is well for the practitioner to state the quantity of blood he desires to have drawn, leaving to the discretion of the leecher the number of animals to be employed. The hemorrhage which sometimes follows a leech-bite can be best controlled by pressure, local application of nitrate of silver, or liq. ferri persulphatis, or tinct. ferri chloridi.

Scarification is generally confined to the division of the conjunctiva in ophthalmia. *Incision*, to the division of the skin in erysipelas, and local periositis.

Of the *constitutional treatment*, general bleeding was for a long time the most prominent. It is now but seldom resorted to; and when used is confined to congestion or sthenic inflammation of the lungs, pleura, peritoneum, or brain. The sudden loss of a large quantity of blood induces syncope; but the patient may suffer slow bleeding to a much greater extent without fainting.

Phlebotomy, or bleeding from the veins, is generally performed at the elbow. A bandage is applied above the joint in order to render the vein prominent. The median cephalic vein is selected to avoid wounding the internal cutaneous nerve. The brachial artery may be wounded if the lancet be thrust too deeply.

Arteriotomy, or bleeding from the arteries, is sometimes performed upon the temporal artery. The operation consists in dividing the vessel transversely. When it is desired to check the bleeding a compress and bandage are resorted to.

Purgatives act as depletives to the watery part of the blood. They are much used in inflammatory affections of the brain or its membranes, where they also serve the purpose of counter-irritants. They are contra-indicated by inflamed or irritable conditions of the mucous tract, and in injuries where perfect rest of the body should be enjoined, as in compound comminuted fractures. The same indications are met by diaphoretics and diuretics. These are more especially indicated in mild cases, and often abruptly determine the course of an inflammatory attack.

Emetics, from their relaxing effect, are sometimes found useful.

Mercury has been much employed in the declining stage of an acute inflammation with the object of removing the exudative product. But its continuance so far as to induce ptyalism has been productive of mischief; and, in this country at least, has excited on the part of the community a feeling of distrust. Opium, in addition to its general soothing effect, is found to be an important remedy, especially useful in inflammations of the peritoneum and intestinal canal.

Surgical Fever.

Surgical Fever is a symptomatic affection following upon traumatic local inflamation; *i. e.*, inflammation following an injury. After shivering or a marked rigor, the pulse in the sthenic form becomes frequent and strong; the skin hot; the secretions diminished in quantity. The intellectual faculties are more or less disturbed. It generally subsides spontaneously with the local affection as the crisis is determined by a renewal of the secretory function of the skin and mucous membranes. In the *asthenic* the

pulse is weak, compressible, running one hundred and thirty to one hundred and sixty beats a minute; the tongue is dry; the thirst is great, and there are oftentimes collections of sordes upon the teeth, while the skin is covered with clammy perspiration: hiccough, subsultus tendinum, and muttering delirium follow. It generally dates from the appearance of erysipelas, hospital gangrene, inflammation of the lymphatics, or of the medullary cavity of bone; and is very apt to be followed by pleuro-pneumonia and inflammation of the membranes of the brain.

Abscess.

An abscess is a circumscribed collection of pus in an abnormal cavity. The formation of an abscess is accompanied by rigors and abatement of the symptoms of inflammation; the pain generally subsides, though, with some kinds of purulent collection, as in those deeply seated beneath fasciæ or periosteum, it becomes greater. There is slight œdema of the neighboring integument, and fluctuation over the centre. This is occasioned by the fluid approaching the surface, a condition recognized as the pointing of the abscess. The skin, soon becoming the only outward barrier, finally gives way, and the pus is evacuated. The abscess, now being converted into a healthy ulcer, heals by granulation. In deep-seated collections the pus, instead of pointing outward, flows in the direction which affords the least resistance. Thus, if among the muscles, it follows the lines of their septa, when the pus is said to burrow; if in the liver, it points towards the small intestine, into which its contents are generally evacuated; if in the abdominal parietes, it points externally, when situated outside of the conjoined tendon of the internal oblique and transversalis muscles, but internally when beneath it.

Chronic or cold abscess implies a collection of pus of slow growth unaccompanied with the usual evidences of inflammation. It is generally caused by a pre-existing subacute inflammation, or the presence of a direct irritant, such as a fragment of necrosed bone or calculus. An œdematous condition of the skin over the seat of the abscess is often seen, and is useful as a diagnostic character. Cold abscess frequently exists for a long time unsuspected and without change, though it may slowly increase, and ultimately attain a great size. It is more frequently seen in scrofulous patients and in others subjected to weakening influences. From these circumstances it is attended with more risk than the acute, and, if large, is apt to be followed by greater exhaustion when opened. If the general health do not appear to suffer from such a collection, it is good practice not to interfere; but sometimes it becomes necessary to evacuate the pus to protect the patient from the effects of septicæmia.

Treatment.—An abscess may in some cases be allowed to open spontaneously; but the general rule is to evacuate the pus by an incision. This should be free, in the acute form; the best instrument for the purpose is the double-edged bistoury, the incision being made parallel to the fibres of the subjacent muscle. In abscesses situated beneath deep fasciæ or periosteum the instrument should be thrust perpendicularly down to the collection and

the incision enlarged as it is withdrawn. No forcible attempt should be made to excite the flow, but an emollient poultice of flaxseed or bread and milk may be applied, and the pus allowed gradually to exude. The chronic form, if small, may be opened like the acute; but if large, and the danger of converting the abscess into an extensive suppurative surface be great, a valvular opening should be employed, to prevent the introduction of air. Opening the collection under water, or allowing the pus to flow from small incisions made at intervals a week or so apart, are among the methods employed to effect this. *Pneumatic aspiration* (Dieulafoy) is sometimes resorted to for greater safety. After the contents are evacuated, if the surface be slow in healing, stimulating and slightly astringent lotions may be injected; and tincture of iodine or mild mercurial ointment may be used externally. To these means may be added—more especially if there be tendency to the burrowing of pus—judicious compression by the roller bandage.

Ulceration.

When an inflamed part breaks down and is destroyed by excessive multiplication and degeneration of its cell elements, ulceration is said to be established. In healthy conditions this destructive change, or molecular death, as it is sometimes called, ceases with the subsidence of the inflammation, the ulcer healing by granulation. But under unfavorable conditions, such as those induced by intemperance, improper or insufficient nourishment, or in constitutions affected with scrofulous or syphilitic taints, progressive loss of tissue is sustained which prevents the healing process being established.

Phagedænic ulcer.—If such destruction be rapid, the ulcer is said to be phagedænic. Such a form is entirely devoid of granulations, and is of uneven depth with sharply defined irregular walls. The surrounding tissues for a short distance are slightly inflamed, and the parts everywhere painful. It generally attacks an open surface, changing a healthy sore, open stump, or chancre to its own character; yet it may occur idiopathically, as in cancrum oris. The constitutional symptoms are severe.

Treatment consists in destroying the diseased surface by nitric acid, acid nitrate of mercury, or caustic potassa; aiding the removal of slough by yeast and charcoal poultices. The system should be supported by nutritious food, to which, if prostration be great, stimulants may be added. The pain should be allayed by opiates. Liq. potassii permanganatis, carbolic acid, or other disinfectants are to be used to correct the fetor, and if practicable the patient should be placed in a separate chamber, access of fresh air being secured.

Weak ulcer.—When the process of healing goes on imperfectly, the surface being covered with pale, tall, conical granulations, flabby and elevated above the surrounding integument, the ulcer is said to be *weak*. This accompanies general debility, or is owing to local defect of vitality, as when the sore occurs in the site of an old ulcer, or cicatrix of a burn.

Treatment.—Altering the character of the part by metallic

astringents, such as sulphate of copper or acetate of zinc. Wash the surface once or twice a day with a mildly stimulating lotion, and bandage the limb.

Indolent ulcer.—When an ulcer possesses high, indurated, whitish walls, which define a smooth or glassy concave surface, showing little tendency to change, it is termed indolent. This variety is most generally situated upon the front of the leg in old or imperfectly nourished persons. The discharge is thin and sanious. The ulcer is not painful; and the patient will oftentimes bear the comparatively slight inconvenience attending it without treatment. It often comes under the notice of the surgeon from some inflammatory complication. The edges of the ulcer are now injected and the surrounding parts are swollen and painful. The treatment consists in subduing the inflammation; afterwards in stimulating the indolent surface, and in compressing the part by strips of adhesive plaster. The general health should be attended to. Perfect rest, the exhibition of an opiate at night, and occasional purgation, hasten the cure.

Irritable ulcer.—This is a superficial variety, with thin, irregularly serrated edges; the surface is smooth and of a dark flesh color, covered with a film of pseudo-membrane or glistening without granulations, and is constantly bathed in a watery discharge which is so acrid as to irritate the sorrounding skin. It is met with on the lower extremities, often in the neighborhood of the ankle-joint, and not unfrequently accompanies conditions affecting the nutrition of the entire limb.

Treatment.—Elevate and relax the part; apply emollient dressings after the application of nitrate of silver. Often sedative lotions produce marked relief. Tonics and liberal diet are often indicated.

The *scrofulous ulcer* accompanies a scrofulous condition of the system. It differs from the above in being less well-defined and in its liability to coexist with a low form of inflammation. The ulceration is preceded by an irregular subcutaneous swelling. The ulcer has irregular, sinuous walls, and discharges an unhealthy pus. The most common sites for its appearance are upon the neck, and extremities about the neighborhood of the joints. It is apt to occur in the adolescent, and is often associated with disease of the bones.

Treatment is chiefly constitutional: the strength being supported by good diet, while cod-liver oil, iodide of potassium, or syr. ferri iodidi, is exhibited. The local treatment consists in the destruction of the ulcer by caustic potassa, and when healthy action has been re-established, in gentle and firm support to the granulating surface. In those cases attended with great and irregular deposition of plastic matter, and chronic and intractable ulceration, amputation of the limb may be the only course left the surgeon, particularly if symptoms of hectic have supervened.

Mortification.

Cessation of vitality in a part is called *mortification*. Commonly a result of intense and long-continued inflammation, it may follow upon any condition where the nutritive supply is withheld,

as in the effects of prolonged exposure of a part to a freezing temperature, or to excessive pressure. It may, indeed, supervene upon any condition withholding blood from a given area. Thus mortification may be occasioned by the formation of clots within vessels, as is seen in *embolism*, as well as in consequence of a contraction of their calibre, as in atheroma; or it may follow upon division of an important artery, as from a knife or bullet. The first evidence of the approach of mortification is seen in the alteration of the natural color of the part. It becomes of a sallow hue, mottled with purple; or a diffuse slate color may be prevalent. These shades deepen with the progress of the condition until the part in time assumes a uniformly black appearance. Vesicles filled with a turbid serum form beneath the epidermis. The limb is cold, flaccid, and offensive. If the tissues be examined at this time they will be found to crepitate under pressure, while no blood flows upon their division, and the part is without sensibility. The line of demarcation defines the limit of the mortified tract. This may be determined either by the locality of the original obstruction, as a bandage or thrombus, but more frequently by a line of intensely inflamed tissue. After the removal of the dead portion at the line of separation, a healthy purulent sore remains which heals by granulation. The act of throwing off the sphacelus is rarely accompanied by loss of blood; but in some cases where the destruction of the softer tissues has been so rapid as to allow the arteries pulsating in the effete tissues to become involved, serious hemorrhage may ensue.

The first constitutional symptom of mortification following upon inflammation is total and often sudden cessation of pain, with loss of heat in the part. This change brings great relief to patients racked by previous suffering. If the case progresses favorably, a line of demarcation forms as above described. But if unfavorably, a typhoid condition sets in; the face becomes pale and cadaverous, the features pinched, and the tongue and fauces dry. The body is bathed in a profuse clammy sweat. The mind is either dull or irritable. The pulse is irregular, compressible, and intermittent. In this condition the patient may linger for some days before death relieves him.

Gangrene is a term nearly synonymous with mortification, and is generally employed to designate the process by which local death is accomplished.

Hospital Gangrene.

Hospital gangrene is that variety of mortification occurring in overcrowded hospitals, particularly among those inmates whose health from other causes—such as exposure to malaria, or scorbutic influences—has become impaired. The atmosphere of the hospital has much to do with its causation. The disease may attack an old cicatrix, but generally affects wounds undergoing repair. The healthy surface is changed to a rapidly progressive phagedæna, possessing a marked tendency to undermine. Hospital gangrene may prove fatal from hectic fever and inanition.

The TREATMENT bears a close resemblance to that for phagedæna. The patient should be placed among pure surroundings.

The part should be thoroughly cauterized after it has been carefully freed of all shreds of sloughing tissue. The best agent for this purpose is bromine either pure or dilute. After the desired slough has formed, a charcoal and yeast poultice, or a dilute solution of carbolic acid should be applied. The system is to be freely supported, care, however, being taken not to overload the stomach. Vomiting not unfrequently arises from this cause, and often proves a dangerous and distressing symptom.

The "antiseptic treatment" of Lister for surgical injuries, amputations, etc., depends upon the exclusion of "disease germs" by the use of dressings saturated with carbolic acid solution or some equivalent preparation. Its comparative advantages have been much discussed; they are probably inferior to those of atmospheric purity and *scrupulous cleanliness*.

Furuncle, or Boil.

A boil, or furuncle, is a small conical swelling of a purplish-red color attended with inflammation. It may occur on any part of the body, but commonly affects the back, neck, thighs, or nates. Seated immediately beneath and involving the skin, it is at all times exquisitely tender. Boils are usually found in clusters, and often accompany some slight constitutional disturbance. Change of habit of life, as from that of the country to the city, or from boarding-school, home, is apt to occasion them. Age and general condition have their influence in producing them, boils being more common with the young and plethoric than with the aged and anæmic. Exceptions to this, however, occur.

Treatment.—Little, as a rule, is required. They, in from three to six days, spontaneously suppurate, with subsequent discharge of the pus or *core*, as the purulent centre is called. This process may be hastened by the use of emollient poultices. Sulphate of quinia, and aromatic sulphuric acid in solution, have been recommended where the boils are tedious or repeatedly recur.

Anthrax, or Carbuncle.

Anthrax, or carbuncle, is a circumscribed inflammation of the subcutaneous tissue, of a flat, circular form, frequently attaining a large size. The involved structures are of a dark purplish-red color; dull or shooting pains are experienced in the part. It differs from a boil in being situated, for the most part, upon the back of the trunk or neck, in suppurating at several points, and in the tendency of the integument to slough in places over the surface. It is less frequently met with in the young than in those more advanced in age; and rarely attacks the robust.

Treatment.—A free, crucial incision made early, the destruction of the unhealthy part by caustic potassa, and the subsequent employment of yeast and port wine poultices have been the means generally resorted to. The part may be rendered insensible by ice, or by the atomization of ether or rhigolene, before the operation. Paget recommends, instead of incision, the application of a piece of lead-plaster, with a hole in its middle for the discharge. The

system must be supported, and attention must be given to the condition of the bowels.

Facial carbuncle is a rare affection, characterized by the formation upon the face of an inflammatory swelling bearing some resemblance to carbuncle, but distinguished from it by a tendency to extend more rapidly, and in occasioning severe constitutional disturbance. It frequently proves fatal by pyæmia.

Erysipelas.

Erysipelas is a zymotic disease, characterized by a diffuse inflammation of the skin and subcutaneous connective tissue. It may be epidemic or sporadic. Sporadic erysipelas is often of a mild *cutaneous* form, or, taking on a severe type, affects the tissues more deeply, when it is termed *phlegmonous*, or *cellulo-cutaneous* erysipelas. Both forms may accrue upon wounds or open surfaces, in which event they are called *traumatic*. The disease is ushered in by shiverings or decided rigors, nausea, pain in the head and back, and a fever which may be of the sthenic, but is more frequently of a typhoid type; the tongue is dry and brown, the pulse is weak and frequent, and not uncommonly the mind wanders. The skin becomes of a scarlet or light purplish color, tense and shining, and the patient experiences acute, burning, throbbing pain in the part. Vesicles filled with clear serum form about the ninth day. If there be a wound it ceases to suppurate, its margins are swollen. In the more violent forms, the subcutaneous tissues pass on to suppuration, the pus extending over large areas, undermining the muscles, but rarely pointing. When developing itself rapidly in a part distant from its original site, it becomes *erratic;* when of a subacute character, accompanied with no redness, little pain, but with infiltration of serum in the tissues, it becomes *œdematous;* and when confined to the subcutaneous connective tissue, affecting the skin secondarily by brawny tension and irregular sloughing, it is called *cellular* erysipelas. The simple cases may terminate by resolution in from seven to ten days; but the severe ones accompanied with formation of pus are more tedious, and not unfrequently prove fatal. Death may ensue from hectic following the excessive discharge, or more rapidly through pyæmia.

Erysipelas is occasioned by certain imperfectly understood conditions of the atmosphere, by foul air, improper nourishment, exhaustion, intemperance, etc. Chronic diseases producing marked debility may also prove predisposing causes, as is seen in albuminuria and diabetes.

The disease is of frequent occurrence in hospitals, especially in those containing many suppurating wounds, as large military hospitals after a battle. There is a tendency in the asthenic form of the disease to become complicated by inflammation of some of the deep-seated viscera. The surgeon should therefore be on his guard against the occurrence of bronchitis, pneumonia, diarrhœa, or, less frequently, of meningitis.

Treatment. *Local.*—The chief objects to be attained by local dressings in erysipelas, are relief of pain, exclusion of the atmosphere, and the removal of the suspected source of infection. After the part is slightly elevated, if such be possible, soothing fomenta-

tions of about the temperature of the body, which may or may not be medicated, are applied. Among these, when a simple form of the disease is present, may be mentioned lotions of lead-water and laudanum, or belladonna. Diluted preparations of bromine—forty drops to the ounce of water, with sufficient bromide of potassium to effect solution, and solutions of sulphite of sodium—have been used with asserted advantage. In facial erysipelas a mild ointment of oxide of zinc may be painted freely over the parts; or the affected surfaces may be treated as a simple burn, and flour or starch sprinkled freely over them. In addition to these, small blisters, or the application of tincture of iodine with a hair-pencil, have been recommended, chiefly with a view of restricting the inflamed area; but they are of doubtful utility.

In the phlegmonous form, early and free incisions are the best of local remedies. These should be made more for the relief of tension than for local depletion, and any active hemorrhage should be promptly checked. Pus is to be evacuated wherever formed.

General treatment.—The constitution often needs generous support, if not stimulation. Tinctura ferri chloridi in doses of ten to fifteen drops, three times a day, acts in many cases admirably. In the epidemic form of erysipelas the patients should be isolated as much as possible.

Pyæmia.

Pyæmia is a constitutional disease, characterized by the formation of metastatic abscesses in different parts of the body. It is never a primary affection, but follows upon a pre-existing disease or injury. It is most frequently met with after wounds, particularly those complicated with injuries to the bones, though it may accrue upon erysipelas, parturient metritis, or diarrhœa. It is an asthenic condition, and apt to appear among those already debilitated. Thus, soldiers in whom malarious and typhoid states are common, are more liable to the disease than civilians. It is the scourge of the military hospital, causing death in the majority of fatal cases following excision of bone and amputation.

Pyæmia appears to be due to the entrance into the blood through the patulous orifice of a vein, not always of pus, as the name of the disease would imply, but of a poisonous element obtained from the ill-conditioned suppurating surface. Thrombi may be formed in the veins of the part, from which minute portions are continually being carried into the circulation, forming, as they are lodged in the remote capillaries, minute plugs which serve as niduses for the so-called metastatic abscesses.

The disease is ushered in by rigors and profuse sweating. The skin generally becomes yellow or assumes the blanched appearance of profound anæmia. The pulse is running and compressible; the respiration hurried; the tongue flabby and tremulous; the breath saccharine. Rigors and profuse diaphoresis, with or without an intervening fever, are of frequent occurrence. The wound becomes glazed, ceases to suppurate, and the flaps of the stump, in the case of amputation, are flabby and liable to slough. Diarrhœa and hiccough are constant and distressing symptoms toward the close. The intellectual faculties are either dull or entirely obscured by

muttering delirium. The formation of metastatic abscesses hastens the progress of the disease, and in the frequent event of their presence in the lungs serve as an exciting cause of inflammation. After death the veins at the seat of the injury may or may not be inflamed, and contain clots, which are either broken down or firmly adherent to the walls of the vessels. Abscesses are seen in the lungs, pleura, liver, joints, and other localities.

TREATMENT.—The patient should be supported by suitable stimulants and generous diet. The wound must be relieved of all irritating or compressing appliances, and, if a tendency to sloughing be marked, enveloped in yeast or charcoal poultices, or some other antiseptic dressing. Every attention should be paid to cleanliness, and access to pure air secured. Little can be done, however, beyond relief, for the affection is almost invariably fatal.

Dissecting Wound.

Severe inflammation and constitutional disturbance sometimes arise upon a dissecting wound, especially in a subject previously debilitated by excessive study, or dissipation. The affected part becomes swollen, the skin brawny and tense ; a pustule forms ; the lymphatics become inflamed, and appear as red lines extending up the limb, followed, if the progress of the disease be unchecked, by abscesses in the glands of the axilla. Great prostration may precede a typhoid condition. Treatment consists in early cauterization of the part ; and, after inflammation is established, in leeching, poultices, or cold water dressing, and application of tincture of iodine along the limb. The patient should be suitably supported, the exhibition of quinia, iron, and stimulants being often indicated.

Glanders.

This is a disease communicated by the horse to man, and capable of being transmitted from one person to another. It is occasioned by the introduction of a quantity of pus from glanders of the horse upon an abraded surface. The local symptoms resemble those of a dissecting wound ; but the swelling is more extensive, the pain greater, while vesicles and minute sloughs are apt to form upon the member. Constitutional symptoms, such as nausea, headache, constipation, and depression of spirits, are always present. The mucous membrane of the nose, frontal sinus, fauces, and trachea becomes inflamed ; a disgusting discharge takes place, while the features are disfigured. Small pustules appear upon the body, followed by profuse fetid sweats. The disease is nearly always fatal, the patient dying in a typhoid condition.

TREATMENT.—Supporting. The infected part should be at once cauterized. The nares should be injected with tepid solutions of creasote, or tannate of iron. Disinfectants are to be freely used about the apartment. Great caution is to be exercised in approaching the patient, since the disease is in the highest degree communicable.

Malignant Pustule.

Malignant pustule is the result of infection from the bodies of animals dying of murrain (bovine disease.) It is confined to the

subcutaneous tissue, and first appears as a painful pimple, which soon becomes a vesicle filled with turbid serum, followed by the characteristic pustule. This sloughs, leaving a gangrenous ulcer averaging an inch in diameter, which may spread rapidly. At the same time the limb becomes enormously swollen. In those cases where the pustules are situated upon the face, the fauces may become involved and death ensue from suffocation. In the severer form of the disease few recoveries take place. The treatment consists in early cauterization of the part with the acid nitrate of mercury, free incision through the inflamed tissues, and supporting the system with wine, iron, and good diet.

Scrofula.

Scrofula is a disease of nutrition, whose nature is yet obscure. It is characterized by gastric irritability, emaciation, flabby muscles, anæmia, thin incurved nails, and tendency to involvement of the lymphatic glands. These latter enlarge, become congested, and finally break down into a cheesy, pultaceous mass, which has been known as the strumous or scrofulous deposit; leaving a ragged, ill-conditioned ulcer if the glands be superficial, but a cold abscess if they be more deeply seated. This degenerative change is not confined to the glands, but may take place in the connective tissues, forming the well-known scrofulous ulcer of the joints, or in various forms of white swelling. When the bones are involved strumous caries is recognized. Skin diseases may take on strumous features, as in eczema of the scalp. The conjunctiva may become affected, the lids red, the eyelashes oftentimes wanting. No tissue is exempt from its attacks, and it is apt to be hereditary. Though most frequent among the poor, the affluent are not exempt.

TREATMENT.—The general health must be improved by tonics and alteratives. Among these may be mentioned iron and iodine. Iodide of potassium, iodide of iron, are favorite combinations. Cod-liver oil has an excellent reputation in treatment of scrofulous affections. Its use must be persevered in for a long time. Change of air, such as is obtained by visiting the sea-shore or mountains, may prove very beneficial. For children and adults moderate out-door exercise should be enjoined. Infants should be frequently carried in the open air.

Syphilis.

Syphilis is an infectious disease, communicated by impure sexual intercourse. It yields a specific pus, which by contact with an abraded or tender surface is capable of extending the affection. Once thoroughly contaminating the system it is never eradicated, and may be transmitted to the offspring of those suffering from the disease. Primary syphilis consists of a specific sore and bubo. Specific sores or chancres are of two kinds—soft chancre, and hard or Hunterian chancre. The *soft chancre* is superficial, oval, slightly concave, with a bright red areola, and secretes a thin pus. It is commonly discovered after an incubation of about two days, upon the corona glandis or frenum of the male, and nymphæ or os

uteri of the female. After passing through the stages of the papule and vesicle the ulcer is formed about the sixth day. About the second or third week after the first appearance of the chancre, though often much earlier, the inguinal glands become inflamed, and "*bubo*" is established. The *hard chancre* differs from the soft in possessing an indurated base, and in being elevated above the skin. It is, moreover, circular in form, of a tawny color, and is often covered with a thin, grayish slough. Pus is not commonly present. Occasionally it is of small size, and may possess no distinctive character apart from the induration. Bubo from this variety is less apt to occur than in the soft; but constitutional infection is much more frequent. Indeed, many pathologists contend that the soft chancre or chancroid, as it is termed, may form a bubo, but has no power of contaminating the system, while the hard or true chancre seldom forms the bubo, but yields to the system the syphilitic virus. The former is auto-inoculable, the latter is not; *i. e.*, the introduction, under the skin, of matter from a sore of the one kind, on the body of the same patient, will produce a specific sore; in case of the other kind, it will not. Such, at least, is the now commonly accepted statement.

Phagedænic chancre may be either hard or soft. The rapidly extending surface is ragged, undermined, covered by a tenacious plastic coat; it yields a sanious, offensive discharge, and is very painful.

Serpiginous chancre is narrow, and extends in superficial tracts up the penis, and may even encroach upon the abdomen. It is mostly met with in scrofulous patients. It retains its specific features longer than the other forms.

Treatment.—The chancre should be at once carefully cauterized with acid nitrate of mercury, or nitric acid. The part should be washed in soap and water after the application, and dressed with a simple unguent. A slightly astringent and soothing lotion hastens the cure; the aromatic wine or yellow wash being among the best for this purpose. Internally, mercury should be given in some form; but it need not be pushed to salivation. Care should be taken in the treatment of the soft chancre to avoid inoculation, the introduction of the virus upon an abraded surface being followed by a specific sore. The phagedænic form should be thoroughly cauterized and dressed with creasote lotion. Bubo may be treated in its early stages by application of tincture of iodine and compression. Should active inflammation set in, leeches and cold applications must be used; if it be too late for this the process of suppuration should be hastened by poultices. When the pus has formed, the parts are to be freely opened and allowed to heal by granulation.

Secondary syphilis is the first result of the virus infecting the system. It is characterized by a roseolous skin disease, preceded sometimes by fever, coming on about the second month, and followed by ulceration within the mouth, iritis, and copper-colored patches on the skin which are free from itching. Mucous tubercles (condylomata) are apt to occur at points of junction of the cutaneous and mucous surfaces, as about the margins of the anus and vagina. Enlargement of the lymphatic glands, falling out of

the hair (alopecia) and rheumatic pains in the limbs and back are also concomitant. Secondary syphilis may be transmitted from mother to child.

Tertiary Syphilis.—In this stage of the affection the bones are quite constantly involved. Chronic periostitis, nodes, caries, or necrosis appearing; the clavicle, ulna, tibia, skull, and femur are frequently the sites of such conditions. Substernal tenderness and nocturnal pains are often marked. The skin becomes the seat of an obstinate circumscribed ulceration—rupia. The joints, nose, larynx, eye, ear, and even the nerve tissue may become involved. Among the latest symptoms may be mentioned the gummy tumor. The connective tissue is the seat of this growth, which is developed most frequently beneath the skin and mucous membrane, though the muscles and testicles may be attacked. The tendency of the gummy tumor is toward suppuration, the subsequent ulcer healing by granulation.

TREATMENT.—Constitutional remedies should be employed with the view of eliminating the poison by acting upon the emunctories. Iodide of potassium in doses of four grains, three times a day, is the most reliable remedy. It is sometimes with advantage combined with protiodide of mercury or corrosive sublimate in small doses. But no form of mercury should be given in those already debilitated by the disease, or suffering from scrofulous taint. Care should be taken not to confound the true syphilitic eruption with that following a long-continued course of iodide of potassium. Ulcerated sore throat is to be treated with local application of nitrate of silver, or a solution of acid nitrate of mercury, employing one part of the salt to four of water. Mercurial inunction and tincture of iodine may be used in subduing the swelling of adenitis.

Tumors—Cancer.

Tumors are of two kinds, *benign* and *malignant*.

The benign or innocent tumor presents three varieties :—

(1.) Those occurring by distension or hypertrophy of the walls of a duct, or from a new formation of a closed cyst in cellular tissue. Examples of this group are met with in ranula (a cystic tumor of the submaxillary gland) and in sebaceous tumors of the head and face.

The TREATMENT consists either in their removal by the knife—sebaceous tumors are best treated in this way—by passing a seton through the tumor if it be a cyst, or by squeezing out the semifluid contents.

(2.) Those arising from simple increase of size of already existing tissues. Such are polypi, glandular growths, fatty and vascular tumors, exostosis, etc.

(3.) Those composed of normal tissue found in abnormal situations. Fibrous, fibro-plastic, cartilaginous tumors are of this kind. A fibrous tumor pursuing a malignant course is termed fibro-malignant.

The following are the most important of the terms applied to non-malignant tumors : Cystoma ; Adenoma (glandular) ; Lipoma, Steatoma (fatty tumor) ; Fibro-cellular (fibroma) ; Myxoma (a soft

tumor, of fibro-cellular or mucous tissue); Sarcoma (fleshy fibrous tumor); Enchondroma (cartilaginous tumor); Osteoma (bony tumor); Myeloid (soft bony tumor; Giant-celled sarcoma), Vascular, and Erectile tumors.

TREATMENT consists in removal of the growth by the knife.

Fig. 325.

CANCER OF BREAST, infiltrating cancer and retracted nipple.

Malignant or cancerous growths differ from normal structures in being sometimes hereditary, and in constituting products never found, at least in the same locality, in a healthy system. They evince their malignancy in the tendency to destroy life, and to recur after operation, either in the original site or in a more remote region of the body. Their minute structure is various, and will not admit of brief description. It is in the main composed of cells, having a diameter of about the $\frac{1}{1000}$th of an inch, and possessing a nucleus with one or more nucleoli. "The term carcinoma is now distinctly applied to such tumors as have a structure of the following description, viz.: A meshwork of fibrous or sarcous substance composing an alveolar structure, whose interstices are filled with cells. These may have no orderly or methodical-looking arrangement, being packed in the crevices in the meshwork (or alveoli, as they are called), and extending casually from alveolus to alveolus, so as to make a complementary meshwork. The carcinomatous character is determined by the presence of such alveolar structure, with cell-collections lodged in it; the decisive point consists in these cells lying close together without any inter-cellular substance; the cells generaly vary in shape, and have large nuclei, with large and bright nucleoli." (Moxon.) Placed in the interstices of a fibrous stroma, it is according to the proportion of the development of this latter structure that malignant growths are classified.

Scirrhus or Hard Carcinoma.—In this variety the stroma is abundant, tough, and resisting giving, a tuberoid circumscribed appearance to the mass when superficial. It is of great hardness, and when fully developed is firmly adherent to the adjacent parts. Upon section it presents a bluish-white, glistening appearance, and yields a creamy, oily fluid known as *cancer-juice.* When situated subcutaneously, as in the mamma, the tumor commonly assumes a dark purple or livid color; and is subject to darting, stinging, or neuralgic pains. It is apt to ulcerate, when the sore will present hard and everted edges, and the neighboring lymphatics will become indurated and enlarged. Scirrhus is found most frequently in

the mamma, liver, stomach, and rectum. It is more frequent in women than in men. It is of slow growth, and rarely occurs before 40 or 45 years of age.

Colloid or *alveolar carcinoma* is characterized by the stroma being tolerably thick, and so arranged as to divide the mass into a number of cystiform chambers, or alveoli, which are occupied by a jelly-like substance. Generally pale and transparent, this may be firm as the white of a hard-boiled egg in the older cells, or of the consistency of half dissolved glue, or currant jelly. In any form it is non-adherent to the walls of the cells, and may be readily removed. The disease assumes two forms, the circumscribed and infiltrated. The former is met with in subcutaneous tissue and in the bones of the extremities, constituting the osteosarcoma and spina ventosa of authors. The latter is seen in the walls of the alimentary canal. It is of much slower growth than either of the above varieties, and rarely or never ulcerates or softens. *Melanosis* is a form either of scirrhus or encephaloid, in which a deposit of black pigment has taken place.

Fig. 326.

Cancer of Bone.

Encephaloid or *soft carcinoma* possesses a matrix less abundant and firm than in the preceding variety. So deficient is this that the mass is of jelly or brain-like consistency. Its cells are for the most part large, with a tendency to assume the caudate form. The growth may be circumscribed (forming tumors often of immense size), or may occur in the tissues as an infiltration. It is elastic, occasionally fluctuating under pressure, as though pus was present. When opened, it shows a whitish-yellow surface, dotted with pinkish spots during life. It is very vascular, giving a purplish-red tinge to the contiguous skin, and possessing, oftentimes, a distinct bruit. Hemorrhage resulting from the spontaneous rupture of some of these vessels is not unfrequent, forming apoplectic clots in the interior if confined, but constituting frightful loss of blood if rupturing the matrix. When ulcerated, the surface of the tumor assumes a dark, sanguineous appearance, in which condition it is often described as *fungus hæmatodes.* From the first, the peculiar cancerous cachexia is better marked in this than in any other kind of malignant growth. Its most frequent sites are the eye, cavities of face, articular ends of bones, the testicles, uterus, and breast. The disease runs its course rapidly.

Epithelioma, or *epithelial cancer*, differs from the above in having an imperfectly defined matrix which possesses a tendency to form concentric laminæ around the cellular elements. These are generally mixed up with altered epithelial cells of the part, and are more constant in their outline than other cancerous growths. Epithelioma is found chiefly at the margin of the mouth, and at the anus, though it is occasionally seen on the hands and feet. Some pathologists distinguish epithelioma from cancer.

Fig. 327.

OPEN CANCER OF BREAST.

TREATMENT. — The same general treatment is applicable to all forms of cancer. If the growth be well-defined, as in carcinoma of the breast, of not very long standing, and not involving neighboring lymphatic glands, it may be removed; but severe hemorrhage from a large encephaloid cancer, or the complication of important structures in any variety having deep attachments, will preclude any operative procedure. Even when extirpated under favorable conditions it is very apt to return, eventually to destroy the patient.

The removal of epithelial growths by the knife, or their destruction by caustic applications before glandular involvement has supervened, in many instances may effect a permanent cure.

SPECIAL SURGERY.

CHAPTER I.

DISEASES OF THE ARTERIES.

Aneurism.

AN aneurism is a tumor formed by the dilatation or rupture of one or more of the coats of an artery. Three kinds are recognized—the *true*, *false*, and *dissecting*. A *true* aneurism is formed by the dilatation of one or more arterial coats. It is more common to find the internal and external membrane defining the mass than all the tunics equally expanded. Among vessels frequently involved may be mentioned the aorta, and popliteal, femoral, axil-

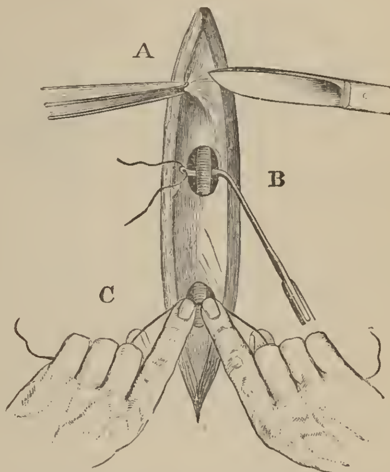
lary, carotid, and external iliac arteries. The disease commences as a small circumscribed tumor which pulsates synchronously with the heart, and is accompanied by lancinating, burning, intermittent pains. These may be neuralgic in their nature when by pressure an adjacent nerve is involved, or they may be chiefly due to the tension induced by the presence of the mass itself. Œdema of extremities may present itself if important nervous trunks be pressed upon—joined to dyspnœa and dysphagia, if the pneumogastric nerve be involved. Bony tissue is not unfrequently absorbed if the tumor rest against it, as is often witnessed in the sternum and bodies of the vertebræ. When the hand is placed over an aneurismal tumor a peculiar thrill is commonly transmitted to the fingers, while its auscultation yields a buzzing or rasping sound. Such symptoms, however, are absent when partial coagulation of the contents occurs. Should such coagulation be complete, and the circulation cease through the tumor, a spontaneous cure is effected. But in the event of the walls becoming gradually more and more distended, and thinned under some unusual strain of the parts, the aneurism may finally burst. Such an accident may speedily prove fatal from excessive bleeding or mortification; but if the bleeding is restrained by the surrounding parts—as is ordinarily the case—the patient may survive it. The tumor—false aneurism, as it may now be called—when examined soon after it has burst, is found to be increased in size, tense, and painful. The limb is swollen, its motion impaired. Constitutional symptoms commonly present themselves in the form of mental anxiety, running pulse, and pallid skin. A *dissecting aneurism* is that variety in which the coats of the artery have so separated as to allow within them the passage and partial retention of blood. It is very rare, and is believed to be confined to aged subjects. Aneurisms, the results of wounds of vessels, are at once converted into false aneurisms, and are spoken of as traumatic. Aneurisms when not traumatic, are the result of a diseased condition of the coats of the artery, "tending to impair their strength and elasticity." It is rarely seen before middle life, and is very often in association with a degenerated condition of the middle coat of the vessel—atheroma. When an aneurismal tumor is dissected it is observed that the mass of the formation is composed of layers of washed fibrin concentrically arranged to the coats of the vessels, while the inner ones are darker and softer.

Aneurism can be distinguished from an abscess situated along the course of an artery by being soft and compressible from the first. The pulsation of an aneurism is equally strong at all points; in an abscess it is most marked over the course of the artery, simply raising the swelling, and disappearing when the tumor is pulled to one side. A solid tumor is not affected by pressure either upon the distal or the cardiac side, while in an aneurism temporary occlusion of the artery passing into it will be productive of a diminution in the bulk of the tumor.

Treatment. *Ligation.*—This is effected by cutting down upon and tying the artery at some point sufficiently remote from the sac to secure healthy tissue. The vessel may be tied, either upon the

cardiac side, a considerable distance from the seat of the tumor, (Hunterian operation) as a ligation of the femoral in Scarpa's triangle for popliteal aneurism; or, as in false aneurism, immediately above the tumor (Anel's operation). Ligation may, however, be effected upon the distal side of the tumor (Brasdor's operation). As now modified (Wardrop's operation) the artery is tied beyond its first bifurcation, as in ligation of the right subclavian for an aneurism of the innominate. At whatever place a ligature be placed, its first effect is to sever the inner and middle coats. A clot is formed above the point of ligation, and a moderate degree of inflammation arising, permanent obliteration of the vessel at that point is secured, the circulation in the limb beyond being effected through the collateral branches.

Fig. 328.



This diagram represent three distinct operations. A. Opening the sheath. B. Drawing ligature round the artery. C. Tying artery.

Different substances have been used for tying arteries, such as fibrous tissue, wire, etc. The silk ligature is the one most generally in use. For certain operations *metallic* ligatures are much employed. The great danger of the operation is secondary hemorrhage from ulceration of the artery, or premature removal of the ligature. Gangrene of the limb is liable to follow the operation upon the lower extremities.

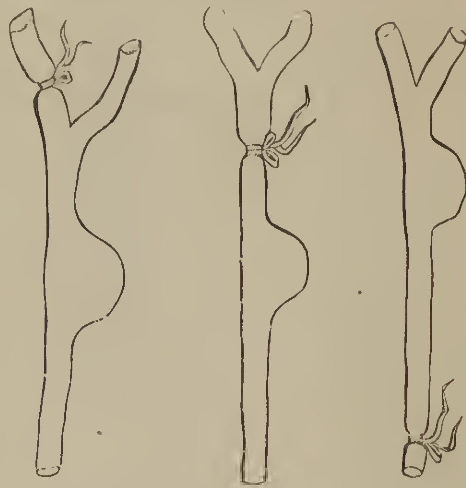
Compression.—This consists in graduated and periodical pressure upon the cardiac side of the tumor, either by means of relays of assistants, or by the tourniquet. It is aided by position of the limb, rest, and dietetics. The *method of Valsalva* consists in gradually reducing the strength of the circulation by low diet.

Manipulation.—Breaking up the clot with the view of plugging the distal orifice, and injection of the sac with an astringent fluid, or inserting horsehair, are operations occasionally resorted to.

Aneurism by anastomosis of Bell is a convenient term given to a group of tumors, chiefly congenital, in which large and dilated arteries are found accompanied with tortuous veins. Such growths are erectile, elicit an aneurismal thrill, and oftentimes accompany encephaloid; they should not be confounded with *nævus*, which is generally less circumscribed and due to enlargement of the capil-

laries only. The term nævus is also applied to forms of discoloration of the skin due to excessive development of pigment cells.

Fig. 329.



TREATMENT of aneurism by anastomosis is by the ligation of the artery supplying the tumor ; by excision or compression.

Injuries to bloodvessels.—It often happens that after a wound of an artery a false aneurism forms in the surrounding parts, either entirely enclosed, as in those arising from injuries inflicted by sharp instruments, or communicating with the exterior through the track of the wound.

TREATMENT.—The vessel involved should at once be cut down upon at the seat of injury and ligated. If the artery be found simply opened, it should be cut across and both ends tied. If the operator neglects this precaution, and ties the cardiac end only, secondary hemorrhage from the distal end will very probably ensue.

Compression.—In hemorrhage from sloughing, or ragged suppurating wounds, where the artery is secured with great difficulty, and renewed bleeding generally follows the Hunterian operation, the main artery of the limb should be continuously compressed as in treatment of aneurism.

Fig. 330.

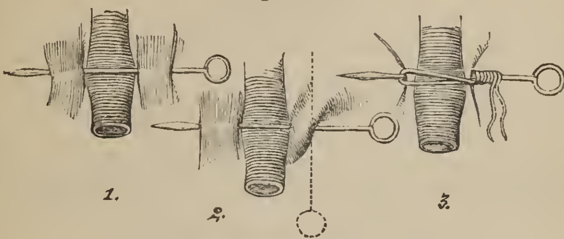
POSITION OF THE ARTERY AND PIN IN ACUPRESSURE.

Acupressure.

This consists in pressure upon the walls of the vessel by means of steel pins.. The instrument is thrust through the tissues down to and *behind* the artery, and brought out on the other side. The vessel is thus

closed from behind forward.[1] The pin may be removed by the third day. It is claimed for this method, by Professor Simpson,

Fig. 331.



that there is less risk of erysipelas and secondary hemorrhage attending its use than with that of the ligature. It is, however, less secure than the ligature. Its principal utility is in *temporary* suppression of hemorrhage; as after leech-bites, for example.

Varicose Aneurism.

Varicose aneurism is the result of a wound involving both artery and vein, through the medium of a cyst. The blood from the

Fig. 332.

artery enters and distends the vein, occasioning a peculiar sound, which has been compared to the rattling of a paper bag, or the purr of a cat. The condition may remain stationary, giving little trouble, for a long time.

Aneurismal Varix.

Aneurismal varix is a similar injury in which the communication is direct, no cyst being present. There is great swelling, varicose condition of the bend of limb below the sac, œdema, stiffness, and diminution of temperature. Graduated compression of

[1] This constitutes the first method, and may be thus distinguished: 1st, vessel between pin and flap. 2d method, vessel between needle and muscle of flap; 3d, vessel between needle and coil of wire above; 4th, vessel between pin and coil of wire; 5th, (Aberdeen) vessel between pin and a mass of tissue twisted upon itself a quarter or a half a circle; 6th, vessel between pin and coil of wire to the side (Keith); 7th, vessel between pin and bone.

the limb alleviates the symptoms; but the only cure for both these affections is ligation of the artery above and below the sac.

Fig. 333.

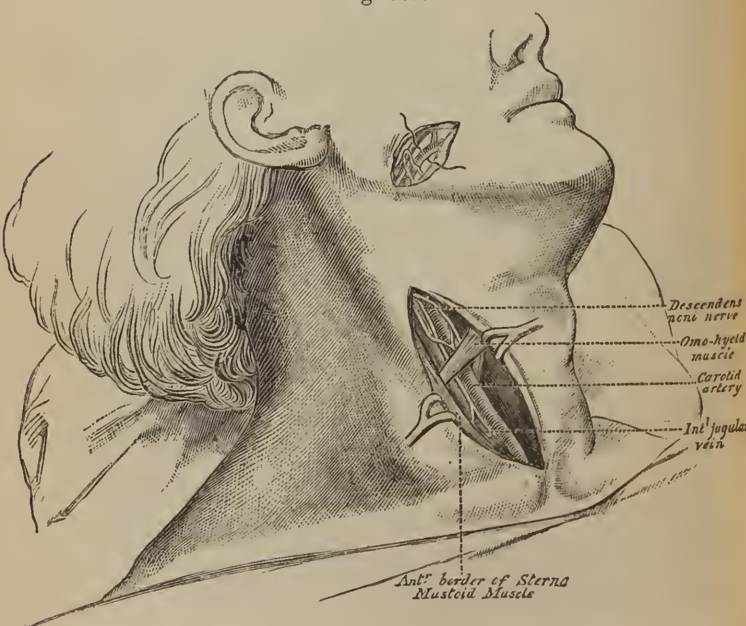
Both of the above conditions are more often found at the elbow than elsewhere, as a result of wounds of the brachial artery.

LIGATION OF ARTERIES.

Aorta.

Ligation of the Aorta.—This operation has been performed in its abdominal portion by Sir A. Cooper, James Murray, McGuire, and others, but without success. Cure of aneurism of the primitive iliac artery has been the object of its performance. This object has been attained by Holden (1866) and others, in several cases, by *pressure* upon the aorta, by means of the abdominal tourniquet.

Fig. 334.



Innominate Artery.

This operation, originated by Mott, of New York, has been performed fourteen times. The only successful case was that of Smith, of New Orleans. The patient should lie on his back with the shoulders thrown forward, and right side drawn forcibly downwards. The line of incision should be from extreme border of the sterno-cleido-mastoid muscle to median line of trachea. A second incision is then made along the anterior margin of the same muscle three inches in length to join the former. The sternal and part of the clavicular origins of the muscle are then divided on a director. The carotid artery is then sought for, which conducts the finger to the innominate. The innominate vein is now depressed, and the needle passed from without inwards and upwards, avoiding the pleura, pneumogastric and inferior cardiac nerves, which lie to the right side.

Common Carotid Artery.

An incision is made along the internal margin of the sterno-cleido-mastoid muscle to the extent of about three inches above the clavicle. The superficial fascia is now divided upon a director and the sheath of the vessels exposed. The internal branch of the descendens noni nerve is seen lying upon it. The sheath is opened and the needle passed from without inward, avoiding the internal jugular vein on the outer side and pneumogastric nerve which is deeper seated. This artery was originally ligated by Hebenstreib, though Sir A. Cooper was the first to tie it for aneurism. Aneurism of the innominate artery has been treated after the method of Wardrop. Dr. Mussey tied both common carotids successfully in the same patient within twelve days, for aneurismal tumor of scalp.

Subclavian Artery.

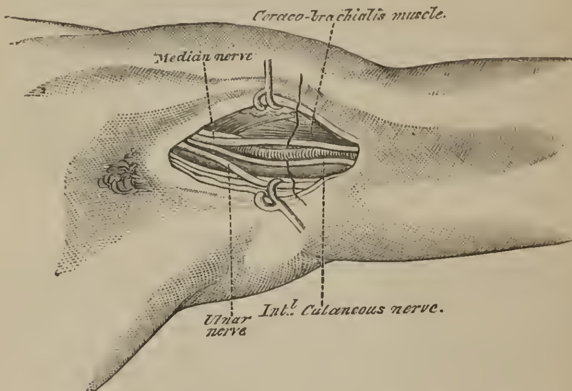
Above the Clavicle.—The patient is to be placed on a table with his shoulders elevated. The incision is commenced at outer margin of sterno-cleido-mastoid muscle, directly above clavicle, and continued outwards for the extent of three inches. The platysma myoides and fascia are now divided. The external jugular vein, supra-scapular artery, and omo-hyoid muscle are pulled aside. The finger is then run along the outer margin of the scalenus anticus to the first rib, upon which behind the muscle the artery is felt. The needle is directed from without inwards. Care should be taken to avoid the branches of the brachial plexus, the internal one of which has not unfrequently been mistaken for the artery.

Below the Clavicle.—A curved incision is made three inches in length running from the middle third of clavicle to the acromion process. The fibres of the pectoralis major are divided and the upper border of the pectoralis minor exposed. This latter serves as a guide to the artery which is found in the space between its margin and the clavicle, with the subclavian vein below in front, and the brachial plexus to the outer side. Ligation of the subclavian has been repeatedly performed for aneurism and wounds of axillary artery.

Axillary Artery.

The incision is made in the middle line of the axilla parallel to the head of the humerus. The coraco-brachialis muscle serves as

Fig. 335.



LIGATION OF THE AXILLARY IN ITS INFERIOR DIVISION.

a guide to the artery, which is upon the outer side of the vein, and in close relation with the head of the median nerve. The needle is passed from within outwards.

Brachial Artery.

This is most commonly ligated at the middle of the arm. The arm is extended and an incision three inches long is made along the internal edge of the tendon of the biceps, keeping close to the muscle and to the inner side of the median basilic vein. The fascia should then be divided on a director. The artery with its accompanying veins lies directly to the inner side of the muscle, the median nerve obliquely crossing it from without inwards. A blunt hook should be employed in drawing away the nerve as the ligature is applied.

Ulnar and Radial Artery.

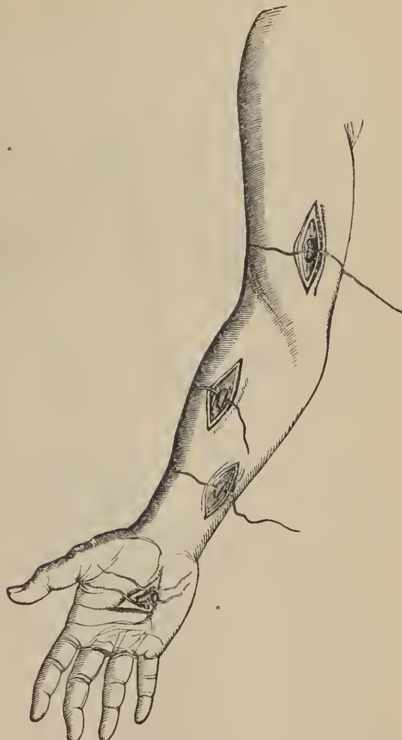
The *ulnar artery* is secured by making an incision along the radial side of flexor carpi ulnaris muscle; the *radial*, by an incision along outer border of flexor carpi radialis, and between it and the supinator longus. These are most commonly tied for hemorrhage from the palmar arch. It not unfrequently happens that the ligation of the brachial is necessary to check such bleeding. Aneurism of either of these arteries is very rare. (See Fig. 336.)

External Iliac Artery.

The incision is made above and parallel with Poupart's ligament, extending three and a half inches from a point one inch

distant from the anterior superior spinous process of the ilium to one and one-third inch to the outside of the pubes. The internal oblique and transversalis muscles are next divided. The transversalis fascia and peritoneum are pushed aside, and the artery is sought for at the bottom of the wound, the vein lying to the inner side. The needle should be passed from within outwards. Great care should be taken to protect the deep-seated epigastric artery and the peritoneum from injury.

Fig. 336.



Ligation of the Brachial, Radial, and Ulnar Arteries; also of the Palmar Vessels.

Femoral Artery.

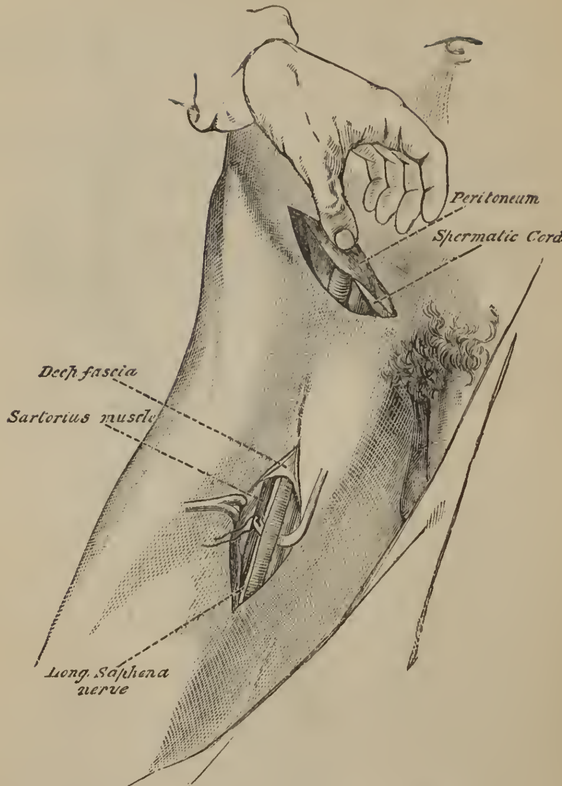
In Scarpa's triangle.—The incision is extended three inches in length along the inner side of the sartorius muscle, commencing two inches below Poupart's ligament. After exposing the sheath by division of the superficial and deep fascias, and avoiding the internal saphenous vein, it should be carefully opened, and the ligature passed around the artery from within outwards, keeping close to the vessel to avoid the vein and some branches of the anterior crural nerve, which usually lie to its outer side.

At its middle third an incision of the same length is made along the inner border of the sartorius, avoiding the internal saphenous vein and long saphenous nerve, firmly securing the vessel by cutting freely through the fascia connecting the adductors to the vastus internus. The needle is passed from within outwards, the femoral vein lying on the outer, and the long saphenous vein on its anterior and outer aspect. This operation is commonly performed for popliteal aneurism. (See Fig. 337.)

Tibial Artery.

The anterior tibial is generally secured by a straight incision made parallel to the tibia, separating the tibialis anticus from the

Fig. 337.

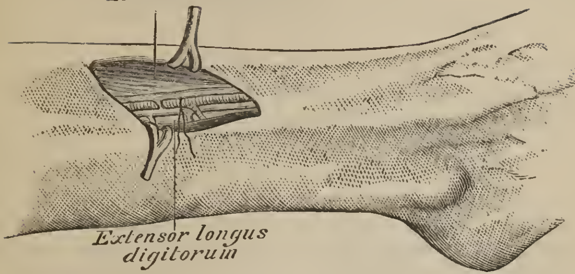


LINES FOR SECURING ARTERIES OF THE THIGH.

extensor communis digitorum. The artery is found deeply seated, with venæ comites. The anterior tibial nerve is upon its outer side. At the lower part of the leg, the external margin of the extensor proprius pollicis serves as a guide, the nerve lying to the outer side. Upon the instep the artery is found between the extensor proprius pollicis and inner border of tendon of extensor communis digitorum. (See Fig. 338)

The posterior tibial at its middle is reached by an incision in the calf of the leg along the inner margin of the tibia ; the fibres of origin of the soleus should next be divided, and the artery sought for upon the tibialis posticus muscle in about the middle line. The venæ comites as well as the posterior tibial nerve, lying upon its outer side, are to be avoided. At the ankle the vessel is superficial,

Fig. 338.



LIGATION OF ANTERIOR TIBIAL ARTERY.

and can be secured by a semilunar incision made midway between internal malleolus and tendo Achillis. The nerve lies to outer side.

CHAPTER II.

DISLOCATIONS.

A DISLOCATION or luxation is the removal of one bone from another at its place of natural articulation. Dislocations are traumatic, spontaneous, and congenital, and may be simple or complicated, complete or incomplete (subluxation), single or double. Generally, the rupture of the capsular ligament is the only lesion accompanying the injury, but in those resulting from great violence, effusion of blood and destructive inflammation of the cartilages may follow. The ball-and-socket joints are most frequently affected. When a wound penetrates the affected joints, a compound dislocation results. An old luxation is generally said to exist after several months have passed without reduction. By this prolonged retention of the head in its abnormal position, the old socket becomes filled up, and a new imperfect joint is formed. The causes of dislocation are external injury, such as blows, falls, etc., and muscular contraction, debility, muscular paralysis, arthritic effusion, diseases and fractures of bones ; a previous luxation acting as a predisposing cause. The symptoms are loss of function, impairment of motion, shortening or elongation of the limb, an unnatural prominence at the position of the head of the displaced bone, and a corresponding concavity in the position of the empty socket. A peculiar friction sound often attends forced motion. Pain and numbness are frequently present.

Dislocation is apt to be confounded with fracture, from which it is distinguished by the immobility of the limb, the absence of

crepitus, the presence of friction sound, the character of the deformity, and the results of an attempt at manipulation.

Treatment.—Return the articular surfaces to their normal relations; preserve perfect rest of the parts until the ligaments have reunited; apply sedative and antiphlogistic lotions; and in time, restore the function of the part by frictions and methodic motion. Forces to replace the bone may be applied in two ways, by extension and counter-extension, and by manipulation. The former is effected by direct force applied to the limb, by means of the pulley or the arms of the operator; the latter, by moving the limb in lines calculated to remove the muscular tension maintaining the dislocation. Either method is made easier by inducing relaxation of the system by the use of the warm bath, an emetic, or what is yet preferable, the exhibition of an anæsthetic.—In compound dislocations amputation so frequently becomes necessary, that opportunities for reduction rarely present themselves. If it be decided, however, to retain the injured parts, the case should be treated as a lacerated wound of a joint. Cautious attempts may be instituted to effect replacement. Active antiphlogistic treatment is very constantly indicated.

Dislocation of the Lower Jaw.

Dislocation of the lower jaw is ordinarily complete, and is produced by each condyle slipping forward beyond the eminentia articularis on the base of the zygomatic process of the temporal bone. It is generally occasioned by a spasm of the pterygoid muscles, with a portion of the fibres of the masseter, while the mouth is wide open. This action is aided by a blow upon the chin from above.

Fig. 339.

Dislocation of the Lower Jaw.

Symptoms.—The mouth is fixed wide open; the chin is unusually prominent; the coronoid processes are felt in the zygomatic fossa; the glenoid cavity is vacant; speech and deglutition are difficult, while saliva flows from the mouth.

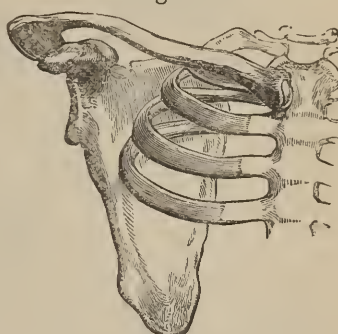
Treatment.—The patient is seated in a low chair, and the operator, protecting his thumbs with a few folds of linen cloth, inserts them far back upon the molar teeth of the lower jaw, presses firmly downwards and backwards, at the same time elevating the chin with the fingers. Nélaton's method is as follows: The operator stands behind the patient,

places his thumbs upon the nape of the neck, and pushes forwards with his finger upon the prominent coronoid processes. After reduction, the chin should be confined by a bandage, for a week or ten days.

Dislocation of the Clavicle.

This is less frequently met with than fracture. It is more common at its acromial than at its sternal end. The acromial is generally caused by a fall upon the extremity of the shoulder, and is recognized by elevation of the acromial end of clavicle, depression of shoulder, increased mobility of parts, and generally inability to extend the arm at a right angle to the body. Reduction is effected by elevation of the shoulder and depression of the clavicle. But it is difficult to retain the parts in their proper relation, owing to the action of the clavicular fibres of the trapezium, and more or less mobility is apt to remain. Desault's third bandage may then be applied. Dislocation of sternal end may be either forwards, upwards, or backwards, named in the order of their frequency. When forwards, the extremity of the bone can be felt in front of the sternum, the corresponding shoulder falls a little back, movements of arm are embarrassed, and there is sharpness of outline of the sternal portion of sterno-cleido-mastoid muscle. When upwards, the shoulder is depressed, with increase of infra-clavicular space. When backwards, there is depression at the articulation—accompanied with difficulty in swallowing.

Fig. 340.



FORWARD DISLOCATION OF STERNAL END OF CLAVICLE.

TREATMENT.—Extension and counter-extension. Reduction is easy, but retention is difficult. Deformity is apt to result. Desault's third bandage may be applied with advantage.

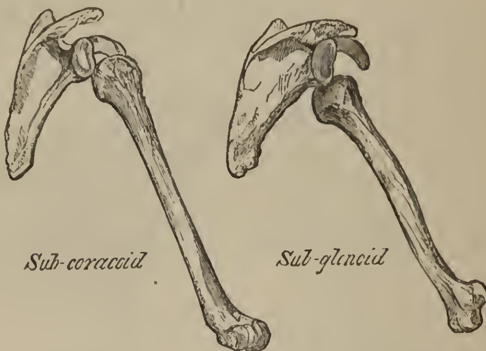
Dislocation of Head of Humerus.

This is more frequent than all the other dislocations, owing to the great mobility of the parts entering into the shoulder-joint, and the shallowness of the glenoid cavity.

Three forms are recognized, viz., axillary (downwards), thoracic (inwards), and scapular (backwards). In the axillary form the acromion is prominent, shoulder flattened, axilla full, elbow projects from the side and is drawn somewhat backwards, while there is great rigidity and immobility. The hand cannot be made to grasp the shoulder of the opposite side. In the thoracic form the acromion is very distinct, the depression being much more marked than in the axillary form. The head of the bone lies in the sub-clavicular space. The elbow stands off in a backward direction, and the arm

is generally shortened from half an inch to an inch. In the scapular variety, which is rarely seen, the head of the bone can be felt in the infra-spinous fossa. The arm is considerably shortened, fixed, and the forearm rotated inwards.

Fig. 341.



Direct violence and contraction of muscular bellies, particularly those of the latissimus dorsi, teres major, deltoid, and pectoralis major muscles are causes of this dislocation. Reduction may be effected either by extension or manipulation. The patient, being etherized, is placed upon his back upon a low table, with his shoulders slightly elevated. A spherical pad is placed in the axilla, and the foot of the operator, the boot having been removed, is used to make counter-extension while extension is made with his hands. If this be ineffectual, a clove hitch band may be applied to the arm, upon which several persons can then pull at once, while counter-extension is made by a towel passed around the axilla and fastened to a head board. The pulley may be employed as a last resort. Under ordinary circumstances reduction by manipulation is preferable to that by extension. By this method the arm, being flexed at the elbow, is carried outwards to the level of the shoulder, then rotated outwards, to be brought quickly downwards and inwards to the side of the body. After reduction, the forearm should be supported in a sling in the semi-flexed position on the chest, a pad should be secured in the axilla, and the arm bound, with a moderate degree of pressure, to the side.

Dislocation of the Elbow.

The most common form of this injury is the luxation of both bones of the forearm backwards upon the shaft of humerus. It is readily recognized by the semiflexed position of forearm, by the prominence of the olecranon behind, and that of the condyles of the humerus in front. The forearm is generally slightly twisted. The coronoid process of the ulna, by its relation with the greater

sigmoid cavity of the humerus, tends to maintain the bones in their flexed position. This accident should not be confounded with fracture of the humerus just above the condyles, which it resembles in general appearance, but from which it can be distinguished by the increased mobility of the parts in the latter injury.

Fig. 342.

FRACTURE ABOVE THE ELBOW.

Reduction is effected by extension and counter-extension, the knee of the operator serving as the point of resistance. The forearm is to be bent while extension is produced. No time should be lost in effecting replacement, delay greatly decreasing the chances of success.

Dislocation of both bones forwards is rarely seen, and is confined in the majority of instances to subjects under fifteen years of age.

Reduction is secured by flexing the forearm upon the arm, making extension by the hand and wrist, and counter-extension by the lower third of the forearm.

Lateral dislocation is rare; it may be either internal or external, but is in either case readily recognized by the extreme prominence of the condyle of the opposite side of the arm. Dislocation of the ulna alone is an uncommon accident. It can scarcely be complete without fracture of the coronoid process. The forearm and hand are slightly flexed, and the olecranon is extremely prominent posteriorly. Reduction is effected in the same manner as in dislocation of both bones. The radius may be dislocated forwards, backwards, or outwards; all are rare, though the first is the most frequent of these accidents. The head of the bone can be felt in its new position; the forearm is prone or slightly supine, and a little flexed. When displaced posteriorly the said head forms a prominence behind; the arm is bent, and forearm prone; when outwards the head lies upon the condyle of the humerus, the bone is higher than natural. Reduction :—the hand is held midway between pronation and supination, and replacement is effected by making forcible extension and supination at the same time, if the displacement be anteriorly; if posteriorly, the forearm should be forcibly supinated, pushing the head of the radius strongly forwards; if outwardly, the radius is pushed downwards and forwards, the forearm being bent at a right angle. The rapid swelling consequent upon lesion at the elbow-joint frequently obscures conditions otherwise readily determined. Immediately after reduction active antiphlogistic measures should be instituted; and, as soon as practicable, passive exercise of the joint should be kept up to avoid anchylosis.

Dislocation of the Wrist.

This accident is rarely met with. It may occur either backwards or forwards. In the former case there is increase of antero-posterior diameter of the wrist, while the fingers are in a semi-

flexed position; in the latter there is a projection upon the palmar surface, and the fingers are markedly extended. Reduction of either variety is, as a rule, easily effected by extension and counter-extension.

The ulna may be dislocated from the radius, backwards and forwards. The former may be recognized by the pronation of the hand—the head of the ulna forming a conspicuous prominence. It may be reduced by flexing the forearm to relax the flexor muscles, and extending the hand, at the same time rotating it outwards. In the latter the head lies in front of the radius, the hand being supinated. Reduction is effected by pressing the head outwards simultaneously with efforts at pronation.

Dislocation of the Bones of the Hand.

Luxations of the metacarpal bones are extremely rare. The phalanges are more liable to such injuries. When the phalanx of the thumb is dislocated backwards upon the dorsum of the metacarpus, there is a large hard tumor upon the back of the joint, while another less distinct is seen from beneath. Reduction is best effected by

Fig. 343.

forcibly extending the phalanx at a right angle to the dorsum of the metacarpus, and then pressing firmly forwards and downwards upon the base of the displaced bone. In dislocation of the phalanges of the fingers extension may be resorted to either by means of the clove hitch, or, what is preferable, by the extending apparatus of Dr. R. J. Levis. The Indian "puzzle" of plaited reed will answer very well; or two narrow strips of adhesive plaster made to surround the displaced phalanx in opposite spirals.

Dislocation of the Femur.

Dislocation of the femur is more common in adults than in children, in men than in women. Four principal varieties are recognized: upwards upon the dorsum of the ilium (Fig. 344), backwards into the sciatic notch (Fig. 345), forwards upon the pubic bones (Fig. 346), downwards into the thyroid foramen (Fig. 347); of these the dislocation upon the dorsum ilii is the most common, that upon the pubes the least.

Iliac dislocation is detected by the limb being shortened from one and a half to two inches, the great trochanter being carried forwards and inwards, the foot being inverted so that the great toe rests upon instep of the opposite foot, the knee being in front and in advance of the sound one. The leg is flexed upon the thigh, while the limb is rigid except a slight motion inwards and upwards. In addition to these signs it will be observed that the gluteo-

femoral fold is higher than natural, and that the upper part of the thigh is unusually full. It may be distinguished from intercapsular fracture of the neck of the femur by the latter injury evincing crepitus, increased mobility, eversion of the toes, and moderate shortening. Moreover, fracture of the neck of the

Fig. 344.

Dislocation of Femur on Dorsum of Ilium.

Fig. 345.

Dislocation of Femur into the Sciatic Notch.

femur rarely occurs before middle life, while dislocation may be produced at any age. Reduction is best effected by manipulation. The leg is grasped by the knee and ankle, and flexed so that the knee will rest beneath the umbilicus, the limb is then markedly abducted; after which the foot is carried across the sound limb, and the knee pushed outwards and downwards, when, the thigh being gently rotated, the head of the bone slips into its socket.

Sciatic dislocation resembles the iliac; the foot is inverted and the limb is flexed; but the foot of the injured side rests against the ball of the great toe of the sound one. The distance between the great trochanter and anterior superior spinous process of ilium is increased. The limb is slightly shortened and incapable of flexion or rotation. The head of the bone rests upon the pyriform muscle, between the sacro-sciatic ligament and upper part of the

68

notch. In reducing this dislocation it is necessary to remember that the head must be removed from its position before it can be restored to the acetabulum.

Pubic dislocation is rare. The head of the femur rests upon the horizontal ramus of the pubes. The characteristic signs are shortening from half to one inch, eversion of the foot and knee, loss of rotation, fattening of the buttock, and presence of a prominence just above Poupart's ligament.

Fig. 346.

Dislocation of Femur into the Thyroid Foramen.

Fig. 347.

Dislocation of Femur on the Pubes.

Thyroid dislocation.—The bone, resting in this variety upon the obturator membrane, increases the length of the limb by one-half to two inches; the iliacus internus muscle is greatly stretched; the knees are separated from one another, and the foot is everted. Extension and rotation are impossible, though adduction and flexion in part remain.

Reduction, in the last three cases, may be secured by manipulation. This may be performed upon the same plan employed in dislocations elsewhere. The old method of reduction by forced extension and counter-extension is now but seldom resorted to.

Fig. 348.

Fig. 349.

REDUCTION BY MANIPULATION.

In dislocation upon the foramen ovale. In ilio-sciatic dislocation.

Dislocation of the Knee.

This is of grave occurrence. It may take place in four different directions: forwards, backwards, inwards, and outwards. The displacement is generally partial. Reduction is effected by extension and counter-extension. Care should be taken in the course of the after-treatment to prevent anchylosis. Congenital luxation of this joint has been recognized, its worst form being forward.

Dislocation of the Semilunar Cartilages.

This injury is most commonly occasioned by a sudden twisting of the joint, as by a slip in walking while the foot is turned inwards. Its symptoms are stiffness of the limb (which is in a semi-flexed position), and excruciating pain, followed by effusion. One luxation predisposes to another. Sudden and extreme flexion, followed by extension, combined with a slight rotary motion, effects reduction. Strict rest for several days afterwards must be enjoined, and the parts supported by an elastic bandage, until the ligaments regain their strength.

Dislocation of the Patella.

The patella may be dislocated anteriorly, posteriorly, or laterally. Of the two lateral forms, the outward is the more common. It is recognized by a depression in front of the knee, by the leg being immovably extended, and by the prominence of the internal condyle. Reduction is accomplished by placing the heel of the patient upon the shoulder of the operator, thus relaxing the great extensor muscle of the leg, while the hand pushes the bone into its place.

Dislocation of the Ankle.

This is of unfrequent occurrence, and is found generally associated with fracture of one or both bones of the leg. It may be for-

wards, backwards, inwards, or outwards. When forwards, the astragalus escapes from between the malleoli to project anteriorly, the foot is elongated, and the depression behind the ankle is effaced. It is reduced by relaxing the muscles on the back of the leg, and pushing back the bone with the fingers. When outwards, which is the most frequent variety, the internal malleolus forms a conspicuous prominence; the foot is everted, and the astragalus can be felt below the external malleolus. The fibula is always fractured. Reduction is secured by flexing the leg—restoring the parts by hand to their normal relations, and retaining them in position by apparatus appropriate for the treatment of fracture. Dislocation backwards may follow upon fracture of the astragalus, causing inversion of the foot. The dorsum is shortened, the heel elongated. Reduction is effected in the same manner as in the case of luxation forwards. The injury to the soft parts is often so extensive in these displacements as to necessitate amputation.

CHAPTER III.

FRACTURES.

A FRACTURE is a solution of continuity of the osseous tissue, produced by external violence or muscular contraction. It may be oblique, transverse, or longitudinal, according to its direction; the oblique being the most frequent. A fracture is *incomplete* when a portion only of the fibres of a bone is divided; it is *simple* when unaccompanied by lesion of the soft parts; *compound*, when an opening in the surrounding tissues communicates with the ends of the broken bone; *comminuted*, when in addition to the last form, the bone is broken into a number of fragments; *impacted*, when the extremity of one fragment is forced into that of another. When laceration of a large bloodvessel, or an opening into or straining of a joint coexists with a contiguous bony lesion, the term *complicated* fracture is employed to designate the condition.

The causes of fracture are predisposing and exciting. Among the former may be mentioned position of the bone, influence of age—the advanced in life being more liable to the accident than the young—constitutional disease, such as syphilis, cancer, scurvy, rickets, etc. The exciting causes are direct, as from blows, falls, crushings from machinery, gunshot wounds, etc., or indirect, as from muscular contraction.

The *signs* of fracture are crepitation, preternatural mobility, and deformity, with pain, swelling, and loss of function. *Crepitation* is the peculiar noise elicited by the forcible contact of the two ends of broken bone against one another. It is absent in impacted fractures, and detected with difficulty in fracture of one of the bones of the forearm or leg. To produce it, the member is extended and counter-extended. Care should be taken not to

confound it with the grating produced by forced motion in an inflamed joint, or within a synovial bursa, or sheath of a tendon: the sounds elicited from such sources are of a finer quality and less distinct.

Preternatural mobility is a constant sign of fracture, few instances being noticed where it is wholly absent; next to crepitation, it is the most important character.

Deformity presents itself in shortening and angular displacement. It commonly immediately succeeds the occurrence of the lesion, but at times, as in a partially impacted fracture of the neck of the femur, it is not seen until several hours afterward. Elongation of the limb is never seen in fracture.

Lesions of bone are repaired in the same manner as in the soft parts, viz., through the medium of a new product—the result of formative action in the connective tissue elements. When the two ends of a broken bone are retained in close apposition, new material is present in small amount; but where much displacement or comminution exists, the quantity is larger. In either case, union occurs by its ossification, either with or without the development of cartilage. The change of the tissue of repair into bone takes place from without inwards; hence, the periphery of the mass may be quite hard, while the fractured surfaces may remain apart. To this substance the older pathologists applied the term callus; two kinds being recognized, the temporary or provisional, viz., that placed around the fragments and in the medullary canal; and the definitive or permanent, that placed between the two ends of the bone, cementing them together. In bones kept more or less in constant motion during treatment, as is the case with the ribs, the uniting tissue enveloping the ends of both fragments, after the manner of a sheath, is called ensheathing callus, while with those—and this is by far the most common—in which the new tissue simply joins the contiguous surfaces, it is termed intermediate callus.

After the fragments have been firmly joined by completion of the process of ossification, those portions of the new tissue not essential in maintaining continuity are absorbed—all sharp angles of the shaft are thus rounded off—and the medullary canal becomes continuous through the site of union.

The process of repair has been, for the sake of convenience, divided into three stages. The first, that of preparation, in which the extravasated blood is absorbed, the swelling subsides, and the muscles accommodate themselves to their new relations. It is estimated to extend from the first to the eighth day. The second includes the time required to form the plastic material, and is calculated from the eighth to the twentieth day. The third—that of ossification—is of greater length, and varies with different bones.

General Treatment.—This consists of measures to support the limb in a proper position during the healing process. The muscles in the case of fracture of the long bones always occasion more or less deformity by the overriding of the fragments; and it is to the reduction of these fragments, or to the "setting the bone" as it is commonly said, that the surgeon's first efforts should be directed. It is accomplished by extension, or force applied to

the distal fragment, and counter-extension, or the "resistance employed to prevent the limb from being dragged along by the extending power." The fractured surfaces, when brought in apposition, are retained by mechanical apparatus which varies in its detail, as applied to different parts of the body, but has always for its object the retention of the broken ends in the position most favorable to good union. Splints are constructed of wood, pasteboard, felt, gutta-percha, or metal. Of whatever material composed they should be light, strong, and padded with hair, wool, moss, or other soft substance to protect the limb from unequal pressure, and of a length sufficient to command the neighboring joints. In fractures of certain of the long bones, the starch bandage, namely, a roller bandage soaked in gum or starch, and applied while wet, has found favor with many, while, in this country at least, the starch bandage conjoined with extension and counter-extension by means of adhesive straps, lateral support being secured from bags of sand, has in great measure supplanted the more cumbersome apparatus of wood. In all cases involving the lower extremity, the greatest care should be exercised in supporting the foot at a right angle to the leg, else by the fall of the foot forward, during the protracted treatment, it becomes permanently extended.

As a general rule no immovable dressing should be applied during the first stage.

In the treatment of compound and comminuted fractures, the dressing last mentioned may occasionally be employed with good results; but such fractures are best treated, on the whole, by means of the fracture box, or splint with a fixed base and hinged sides, within which and about the injured limb a quantity of bran is loosely packed. A part of the early treatment of gunshot fractures is, in many instances, the discovery and removal of the ball. The detection of the latter is to be sought for with the finger, or a silver or (Nélaton's) porcelain-headed probe. Sometimes an electrical apparatus is used to give indication of the contact of a metallic body. Removal of a deeply-seated ball may be effected with bullet-forceps. Sometimes a ball not found becomes encysted and remains in the part for many years.

At times when, owing to constitutional causes, or, it may be, unskilful treatment, union of the fragments is delayed, occasional friction of the ends of the shaft against one another, while small blisters are employed externally, may be found useful in exciting the formation of the ossific matter essential to union. A more reliable procedure, however, is recognized in the insertion of a seton between the fragments, or in the operation of drilling the opposed ends of the bone, and uniting them subsequently by silver wire.

Fracture of the Nasal Bones.

These are generally fractured by blows or falls. Occasionally serious cerebral complications, or subsequent caries of the bone, may supervene.

Treatment.—The fragments should be moulded into position by the hand, while depressed fragments should be pressed upward

by means of a grooved director or female catheter passed into the nose. If a tendency exists for the bones to renew their old position, a stout adhesive strip, carried across the bridge of the nose from one cheek to the other, effectually checks it. Union may be expected from the fourth to the fifth week.

Fracture of Malar and Superior Maxillary Bones.

This results, either combined or singly, from strong direct violence, and is usually accompanied by considerable crushing and wounding of the soft parts.

Treatment.—But little dressing is required. Keeping the parts at rest, and wiring together any movable fragments of the alveolar processes, present in general all the means required. The mouth should be kept shut, and the patient allowed none but liquid food.

Fracture of the Lower Jaw.

This bone is commonly broken at the anterior third of the longitudinal ramus: in young subjects it may part at the symphysis. It is caused by direct violence, as a fall or a kick. Unskilful dentists have not unfrequently broken off large portions of the alveolar processes in extracting teeth. The injury in its ordinary form is recognized by the anterior portion being drawn downwards by the muscles of the throat, and the posterior upwards by the masseter. The front teeth are out of line, and the mouth distorted. There is also pain, swelling, salivation, and at times deafness. The diagnosis of fracture at the neck or ramus is more obscure. The crepitus is heard by the patient, and there is pain in the corresponding ear.

Fig. 350.

Fig. 351.

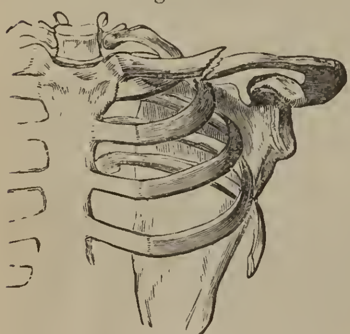
Treatment.—This consists in retaining the fragments in position by wiring the teeth together, and supporting the bone from without with pasteboard or gutta-percha splints moulded to the chin and jaw, and a Barton, Gibson, or four-tailed bandage

applied. The principle, with either, is to keep the lower jaw in its place, closed against the upper jaw.

Fracture of the Clavicle.

The clavicle is often broken, generally by indirect violence, as a fall upon the shoulder, arm, or hand. Its exposed position predisposes it to injury. The fracture is most frequent at the middle of the bone; but sometimes is at the acromial end. It is generally oblique; and is readily recognized by the crooked appearance of the shoulder, which is sunken, being drawn downwards and inwards. The arm cannot be rotated, nor, as a general rule, can the hand be carried to the face. There is much displacement, the outer fragment being drawn forwards and inwards by the action of the subclavius and pectoralis minor muscles. The patient generally supports the arm at the elbow.

Fig. 352.



Complete Oblique Fracture near the Middle of the Clavicle.

Treatment.—To restore the fragments to their normal relation the arm is elevated, drawn backwards and slightly outwards. The apparatus of Desault is designed to meet these indications. It is composed of a wedge-shaped pad and three roller bandages. To apply this dressing the pad is placed in the axilla with its base upwards and retained in position by the first roller bandage, around the chest. The arm is next brought to the side by means of the second roller, care being taken to firmly fix the elbow. The third roller draws the arm upwards and backwards; and is applied by placing the initial end of the roller in the axilla of the sound side and carrying the bandage obliquely across the compress in front, down the posterior part of the arm under the elbow and obliquely upward across the chest whence it started; then reaching the affected side from behind, it is passed down in front of compress and arm to elbow, behind which it is carried to again reach the point of starting by passing obliquely upwards and backwards to the opposite axilla. This is a secure dressing, and well suited to maniacal cases; but in warm weather it requires frequent renewal, and is but poorly borne by the patient. It has been almost entirely superseded in this country by the apparatus of Fox. This consists of the wedge-shaped pad of the preceding dressing, held in position by strings fixed to a collar borne around the shoulder of the sound side, which in addition secures in position a sling into which the forearm and region of the elbow are suspended. This apparatus has been modified by Levis, who extends a broad bandage from the upper end of the pad across the back of the neck to the sound shoulder, and to its free end secures the straps of the sling.

Another method of treatment is by placing a pad over the blade of the scapula below its spine, and then surrounding (or half surrounding) the chest by broad adhesive straps; the arm of the injured side being drawn up by a sling towards the sound shoulder. If the patient can be kept lying in bed on his back during the treatment, in many cases no apparatus at all will be required. In some cases, the best possible management will leave a slight deformity.

Union is obtained from the fifth to the eighth week; in children from the eighteenth to the twenty-fifth day.

Fracture of the Scapula.

The scapula is rarely broken; it may be fractured through the acromion, neck, coracoid process, and body. The indications are to keep the parts at rest and support the humerus. Union in fracture of the acromion process is rarely osseous.

Fracture of the Humerus.

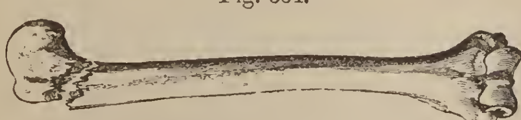
At Anatomical Neck.—This generally occurs in children, when it consists of a separation of the epiphysis; it may, however, occur in adults. *At Surgical Neck.*—This is not common, and most commonly results from a fall upon the hand or elbow, or from direct violence. The head of the bone can be felt, drawn outwards and slightly backwards by action of the scapular muscles, the shaft is drawn upwards and inwards by means of the pectoralis major, latissimus dorsi, and teres major muscles. As a result the arm is shortened; the deltoid muscle is flattened and the member slightly twisted.

Fig. 353.

FRACTURE OF ANATOMICAL NECK OF THE HUMERUS.

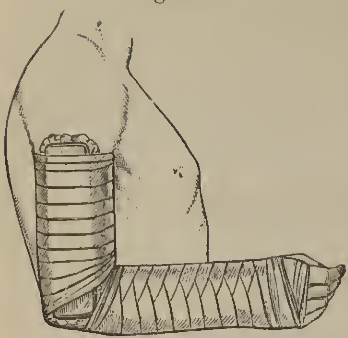
TREATMENT.—Consists in fixing the shoulder and humerus by splints upon the inner and outer surfaces of the arm (the latter being the longer), secured by the roller bandage, or by a leather or gutta-percha cap around the shoulder. Union may be expected in five or six weeks. When dislocation of the head of the bone coexists, efforts should be made first to reduce the bone before placing the limb in splints. This is always a matter of difficulty, and is at times impossible. In such cases the upper extremity of the bone should be retained in close relation to the glenoid cavity with the hope that a false joint may

Fig. 354.



FRACTURE AT SURGICAL NECK OF THE HUMERUS.

Fig. 355.



form between the shaft and the scapula. Fracture of the shaft is readily recognized, and is treated as in fracture of the neck. Union takes place from the fifth to the sixth week..

At the Condyles. This form can be recognized by the radius and ulna projecting forwards, the forearm being slightly flexed.

It is readily distinguishable from dislocation by mobility and crepitation. When the inner condyle is alone separated, the ulna projects backwards. Fracture immediately above the condyle is met with not unfrequently among children.

TREATMENT.—Consists of a rectangular splint for arm and forearm, supported by a sling. Care should be taken to prevent anchylosis.

Fractures of Shafts of Radius and Ulna.

When these bones are broken conjointly, the fractures are generally at the lower third of the forearm, and are most commonly oblique and upon the same level. There is little difficulty in recognizing this condition.

Fig. 356.

FRACTURE OF THE LOWER END OF THE RADIUS.

TREATMENT.—Two well-padded splints are applied, one upon the anterior and one upon the posterior surface of the forearm, care being taken to preserve the interosseous space ; the splints are retained by a roller bandage, and the whole is suspended in a sling, in a position midway between pronation and supination. Union may be expected in the fifth or sixth week.

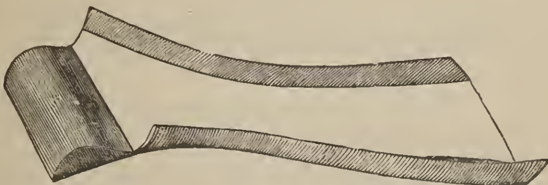
Fracture of the Radius.

The radius is more frequently fractured than the ulna, owing, through its broad articulation with the carpus, to its liability in falling to receive the force of the shock upon the hand. It is most common at about half an inch above the wrist-joint. When it enters the joint we recognize "a Barton fracture ;" when one and a half inch above it, "a Colles fracture." The lesion is easily detected by the prominence of the region of the styloid process of the ulna. An elevation exists upon the dorsal aspect, corresponding to which on the palmar surface is a well-

marked depression. The condition assimilates dislocation, but can be distinguished from it by the disappearance of the deformity upon the employment of extension and counter-extension.

Treatment.—Consists in placing the affected arm in a Bond splint (Fig. 357) and retaining it in position by a roller bandage.

Fig. 357.



Bond's Splint for the Front of the Forearm and Hand.

The object is to prevent the extensors of the thumb from maintaining the deformity by their tension, while the fingers have free motion upon the elevation at the end of the splint. If this apparatus cannot be procured, a single splint cut in the shape of a pistol should be applied upon the ulnar aspect of the arm, its curved portion serving as a part by which extension can be secured, and the hand bent towards the ulnar side.

The forearm should be supported in a sling. Union occurs from the fifth to the sixth week. Fractures at the neck can be detected by the projection of the upper end of the lower fragment in front. They are treated in the same manner as fracture of the shaft.

Fracture of the Ulna.

This fracture is most frequent at the lower third of the shaft. The lower fragment is very commonly drawn towards the radius through the action of the pronator quadratus, occasioning a marked depression upon the anterior face of the forearm.

Treatment.—It is treated by splints placed upon the anterior and posterior aspects of the limb, while the parts are so bandaged as to throw the lower fragment outward, an indication best met by retaining the hand in a position bent inwards.

The olecranon process (Fig. 358) is broken either by direct violence or by inordinate action of the triceps extensor. The fragment is drawn upwards, leaving a hollow at the back of the elbow. The limb is semiflexed and cannot be extended.

Fig. 358.

Fracture of the Olecranon Process.

Treatment.—Forcibly extend the limb, permanently retaining

it in its new position by two wooden splints placed upon opposite sides of the limb. Union is rarely other than ligamentous.

Fracture of the coracoid process (Fig. 359) is very rare. The detached portion is carried from the shaft by the brachialis an-

Fig. 359.

FRACTURE OF THE CORONOID PROCESS.

ticus, while the triceps, acting powerfully upon the ulna, now that the opposing force of the flexor is removed, draws that bone backwards and may even dislocate it.

TREATMENT.—Secure the arm in rectangular splints and support it in a sling. Union is always ligamentous.

Fractures of the Carpus, Metacarpus, and Phalanges.

The bones of the carpus ordinarily escape fracture. There is always complication of injury of the soft parts. The metacarpal bones and phalanges are liable to simple fracture, generally induced by direct violence. The treatment of both forms consists in placing the fragments in position and retaining them by means of splints and a roller bandage. Union may be expected in about three weeks.

Fig. 360.

INTRA-CAPSULAR FRACTURE OF THE THIGH BONE.

Fracture of the Femur.

At the Neck.—The bone may be broken within the capsule of the hip-joint (intra-capsular) or without (extra-capsular). *Intra-capsular* fracture occurs in old persons, and most frequently in females. Slight causes are sufficient to produce it, such as a false step, a fall from a lounge, a twisting of the foot in the carpet, etc. The most marked symptoms (Fig. 360) are eversion of the foot due to the action of the external rotators and the weight of the limb—a degree of shortening ranging from half an inch to an inch; crepitation, when rotation is effected while extension and counter-extension are maintained; and the depressed condition of the great trochanter, which upon rotation describes a smaller arc than that upon the opposite side. There is but little shock. Perfect union rarely occurs. The fragments are sometimes joined by a fibro-ligamentous substance, seldom or never by an osseous one. This is owing to a change in the osseous tissue of the neck of

the femur attendant upon old age, to imperfect nutrition of the part, which at best is feeble, and to the presence of synovia about the fragments. In the effort of the tissues to effect repair, large masses of new bone are formed upon the upper end of the shaft. When the fragments are impacted, while the diagnosis is obscured, the prospect of a bony union is more encouraging. But in its ordinary form, in aged persons, no hope can be entertained of such a result; and the object of the treatment should be to encourage the formation of the fibrous band, by supporting the limb upon pillows, and maintaining moderate extension and counter-extension—the formation of bed-sores being as far as possible prevented.

Extra-Capsular Fracture.—This is less frequently met with than the preceding variety. It is more often seen in men than in women, and is almost peculiar to those past fifty years of age. It is commonly occasioned by direct violence. The symptoms are, shortening, which varies in degree from half an inch to two inches; loud crepitation, elicited without extension and counter-extension; and eversion, which, however, is not constant, since, in a considerable number of cases, the limb is strongly rotated inwards. The shock is severe and mortality great. Osseous union takes place from the eighth to the twelfth week.[1] Fracture of the great trochanter rarely occurs alone. It is generally met with in elderly persons, and is the result of direct violence. Union is mostly ligamentous; approximation and retention of the fragments being difficult.

TREATMENT, as in fracture of the shaft.

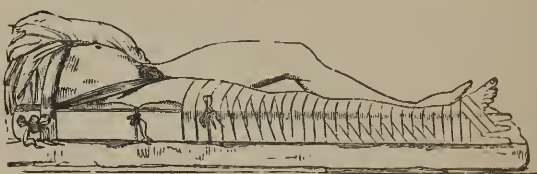
Fracture of the shaft may occur at upper third, middle, and lower third. At upper third the upper fragment is elevated, and, in the majority of cases, turned outwards; at the middle the shortening is great, while the limb is markedly everted; at the lower third the distal fragment is always drawn upwards and backwards. The knee-joint may become involved by the opening of the capsule by the upper fragment.

TREATMENT.—The methods of treating fracture of the thigh are numerous. All have for their object the retention of the fragments in their normal relations until union has taken place. The Desault apparatus consists of three splints: the first or outer one extending from the crest of the ilium to four inches beyond the sole of the foot, an upper splint extending to the knee, and an inner one reaching from the perineum to the sole of the foot. Extension is made from the ankle to the lower end of the long splint—counter-extension by a band attached to its upper end, extending around the perineum. This apparatus was modified by Physick, who made the outer splint extend from the axilla to beyond the sole of the foot. Dr. Gross' modification consists in combining

[1] The difference of opinion prevalent as to the possibility of the inter-capsular fracture uniting by bone, is probably due to the fact that the line of insertion of the capsular ligament upon the femur varies in different individuals, and this has been overlooked. In some persons the insertion may be in proximity to the head, while in others it is nearer to the junction of the neck and shaft. It follows, that of lines of two fractures relatively of the same position, one may be within and the other without the capsule.

the long splints with the support given by the fracture-box. The Hagedorn apparatus secures counter-extension from the opposite side by fixing the sound limb to the foot-board of a long splint, extension being effected as in the dressing of Desault. Good counter-extension may be obtained by tilting the end of the bed, and extension by a weight at the end of a cord which passes over a pulley to be attached to the foot. The weight-extension may also be employed with counter-extension from the perineum to the side of the bedstead or to an external long splint. The limb should be supported by a roller bandage, and, it may be, by bags of sand applied to its sides. The displacement of the proximal fragment

Fig. 361.



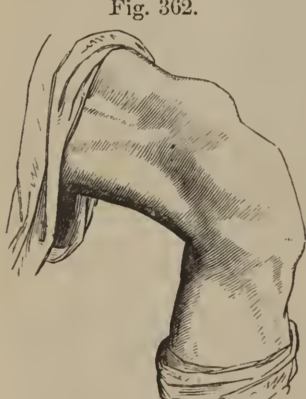
DESAULT'S APPARATUS APPLIED.

in fractures of the upper third is best combated by elevating the lower fragment to the position assumed by the upper, by means of the double inclined plane. Whatever apparatus be employed, all needful ends being attained, the simpler it is the better.

Fracture of the Patella.

This bone may be broken either by muscular contraction or by direct violence. The fracture is commonly transverse, though it may be oblique or vertical. The lesion is often made evident to the patient, by the audible snap attending its occurrence. The two fragments are separated some distance from one another (Fig. 362), a marked depression existing between them; and the patient is unable to walk. There is little or no pain. The object of the treatment is to approximate the fragments, and retain them in position. For this purpose the limb is elevated to relax the extensor muscles, and the fragments are brought as nearly as possible into position by means of a compress and adhesive strips, the knee being inclosed in a figure-of-8 bandage. The union is very generally ligamentous, when fracture is transverse, and may be expected from

Fig. 362.



DEFORMITY AFTER FRACTURES OF THE PATELLA.

the ninth to the tenth week. Malgaigne's treatment by approximating the fragments with pointed wires, is not free from danger of inflammation; but it has sometimes succeeded well. One fracture predisposes to another, as the liability of the bone of the opposite side to injury is increased.

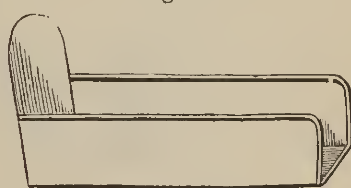
Fracture of Bones of the Leg.

The tibia and fibula may be broken separately or conjointly. The most frequent site of lesion in the *tibia* is at its lower third. The deformity is marked, the sharp edge of the upper fragment is elevated and sometimes pierces the skin, and a corresponding depression exists below it. When broken at or above its upper third, the deformity is slight. The fibula serves as a splint in retaining the fragments in position. Union occurs about the fifth week.

TREATMENT.—The limb should be placed in a fracture-box (Fig. 363), or wire splint.

The *fibula* may be broken at any part, but most generally at its inferior fifth. This form is almost invariably occasioned by forced lateral motion at the ankle-joint, and is always accompanied by its subluxation. There is eversion of the foot, increase of space between malleoli, elevation of the external margin of foot, and depression of the internal margin.

Fig. 363.



FRACTURE-BOX.

TREATMENT.—By Dupuytren's apparatus. A splint is applied extending from above the knee or inner side of the leg to beyond the foot. A wedge-shaped pad fills in the space between

Fig. 364.

DUPUYTREN'S APPARATUS.

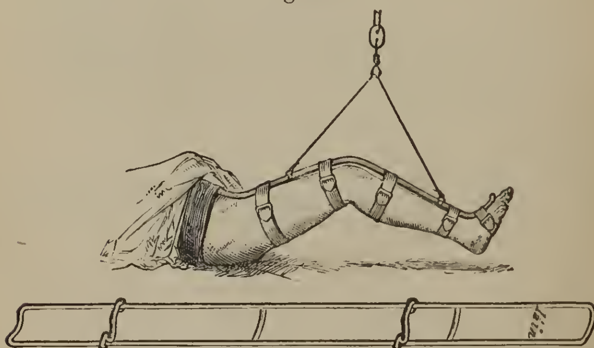
the limb and splint. A bandage is then applied to fix the upper end of the apparatus, and then to bring the inner border of the foot towards the splint to correct the eversion. Union occurs about the fourth week.

When both bones are broken, the shortening is marked, especially if the fractures occur, as they frequently do, at their lower fourth. The lines of fracture are rarely opposite one another, the fibula, as a rule, being fractured at a point above that of the tibia. The upper fragment of the tibia projects anteriorly, and if markedly

oblique, offers a troublesome feature to combat during the treatment. Care should be taken not to promise a cure without deformity under these circumstances.

TREATMENT.—The use of the fracture-box with pillows generally furnishes good results. If extension and counter-extension be deemed advisable, they should be secured by means of adhesive strips, rather than by the gaiter or handkerchief. Of late years, suspension of the limb after the application of the apparatus, as a means of adding to the comfort of the patient, has met with favor. The fracture-box thus suspended, proving too cumbersome, the apparatus of Salter, or Prof. N. R. Smith, may be employed in its stead. The latter, much used in this country, is known as Smith's anterior splint, and is applicable to any fracture of the lower extremity. It consists of a wire framework bent to the

Fig. 365.



form of the partially extended limb, the two sides being strengthened by transverse bars. It is applied upon the front of the limb, the turns of a broad roller bandage, passing from the sides of the splint around and beneath, serving as a cradle in which the limb lies, while the whole is suspended by cords. In compound fractures of these bones, the use of the fracture-box with bran dressings constitutes, in the opinion of many, the best mode of treatment.

Fracture of the Bones of the Foot.

When the calcaneum is fractured, which rarely occurs, the symptoms presented are inability to extend the foot, and a protuberance at the lower and back part of the leg. The lesion is slow in uniting, six weeks being required to effect union, which is often ligamentous. The gastrocnemius muscle has a tendency to displace the upper fragment.

TREATMENT.—Place a splint extending from near the knee to the toes, upon the anterior part of the limb; and by its means keep the foot permanently extended upon the leg. The calf of the leg and foot may be bandaged in opposite directions. The astragalus

is rarely fractured without complication with tibia and fibula. It may be successfully treated by the fracture-box. In the event of failure in effecting union, amputation of the foot or excision of the joint should be performed. The metacarpal bones and phalanges are not often fractured alone, and are very generally associated with great laceration of the soft parts.

Fracture of the Sternum.

This fracture is rare. It generally arises from direct violence, though muscular contraction has been known to produce it. It is characterized by depression at seat of injury, pain, dyspnœa, and, it may be, palpitation and spitting of blood. The displacement can be remedied by bending the chest over a pillow placed under the back. The fragments are adjusted and retained by broad adhesive straps, applied as in fracture of the ribs. Life is endangered by this injury.

Fracture of the Ribs.

This is of more frequent occurrence with the central ribs. The line of lesion is generally at the middle third when the result of direct violence, though more commonly of an indirect force applied to either end of the bones, as in antero-posterior compression of the chest. The fracture is recognized by the crepitus which is oftentimes felt by the patient upon inspiration, when, from the amount of fat beneath the skin, it escapes the notice of the surgeon. The pain is acute, and may be accompanied by emphysema of the subdermic connective tissue. Pleurisy, induced by the irritation of a sharp spicule from one or the other of the fragments, occasionally occurs.

TREATMENT.—Coaptation of the fragments is to be effected by compresses placed over the seat of fracture, if there be angular displacement outwards, or over either end of the bone, if there be much displacement inwards. These are to be held in position, and the movements of the affected side restricted as far as possible, by strips of adhesive plaster one inch and a quarter wide, applied from the dorsal spine to the sternum.

Fracture of the Vertebræ.

This is of rare occurrence, and most generally occurs upon direct violence, as from falls and blows. It is accompanied by marked contusion or laceration of the surrounding parts, and injury to the spinal cord. The symptoms vary with location of the lesion and degree of compression. When in the cervical region, the arms are paralyzed; and if the lesion be above the fourth vertebra, the function of the phrenic nerve (which supplies the diaphragm) is greatly impeded, and death soon ensues. When in the dorsal region, the bowels are torpid, and there is retention of urine. If death do not take place at the time of reception of the injury, the patient may linger for a long time. When in the lumbar region, there is paralysis of the lower limbs, retention of urine, relaxation of the sphincter ani muscle, involuntary evacuations, and occasionally priapism.

Treatment.—Rest in the recumbent position upon a mattress so arranged as to allow relief of the calls of nature without change of position. In cases of fracture of the neck, special pains should be taken to prevent the head from getting lower than the rest of the body, for death might ensue from the impediment thus offered to the descent of the diaphragm. It has been proposed to trephine the seat of fracture, with the view of removing the depressed fragments. But no benefit has resulted from such treatment in those cases in which it has been essayed. Perfect cleanliness should be enjoined, and pains taken to prevent the formation of bed-sores. In the latter stage of the treatment, the use of electricity externally, and strychnia internally, promises some relief; though if the spinal cord has been much injured, no permanent benefit can be expected.

Fracture of the Pelvic Bones.

Fracture of the *innominate* bones, almost invariably, follows upon direct violence. There is little displacement, nor can the extent of injury be determined with any accuracy during life. When the acetabulum gives way, the limb of the corresponding side is drawn upwards and slightly forwards. The accident is at all times serious, and is rendered doubly so by the occurrence of rupture of the bladder. Among sixty-five recorded cases of this fracture, twenty-four proved fatal. The *sacrum* is usually fractured longitudinally. The *coccyx* may be broken by a blow from without, or by a force from within, as in the female, during childbirth.

Treatment.—Absolute rest must be enjoined. The urine must be drawn off by the catheter. If there be any displacement, a broad bandage applied around the hips promotes union, but in general this can be dispensed with.

CHAPTER IV.

DISEASES OF BONES.

Caries.

Caries is an unhealthy ulceration of bone, accompanied by a low form of inflammation. It is most frequently seen in young persons of a strumous habit, with whom it generally attacks the cancellated structures—the regions of the tarsus, carpus, and sternum being frequently involved. The epiphysal extremities of long bones also often become carious: the head of the tibia and that of the humerus being favorite sites for its ravages. Caries may also occur in a syphilitic subject, when it more commonly selects the surfaces of flat bones, as those of the vault of the cranium. When a carious bone is examined in the fresh condition, its interior is found to be preternaturally softened, and often partially occupied by a yellowish, cheesy matter, which may

either be tubercle or the desiccated product of an old purulent deposit. A dried carious bone is ragged, apparently worm-eaten, of a chalky whiteness, and very friable.

The symptoms are pain, swelling, and a fetid discharge. The neighboring tissues are traversed by sinuses leading to the bone. The skin is tense, and of a purplish-red color.

Fig. 366.

TREATMENT. — Scrape away the crumbling and ulcerated space, and improve the general health by tonics, alteratives, sea-bathing, travel, etc.

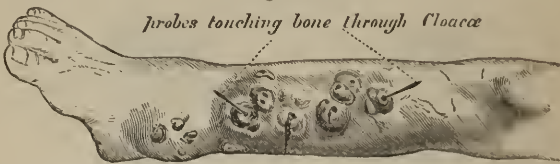
Pott's disease, or caries of the spine, is seen in young subjects of scrofulous habit. The bodies of the affected vertebræ, chiefly those of the dorsal region, break down ; pus either points at the seat of disease or gravitates along the course of the psoas muscles, to appear at the femoral region. In the commencement of the disease, the symptoms are dull, aching pain in the back, unsteady gait, sensation of numbness of the lower extremities, and derangement of the digestive organs. Later, there is marked antero-posterior curvature of the vertebral column, with angular projection backwards of the dorsal spines. Paralysis of the lower extremities may occur from pressure upon the spinal cord. If the disease be left to nature, cure may be effected by anchylosis—the patient being deformed for life. Absolute rest upon a mattress, the wearing of supporting apparatus, counter-irritation along the spine, with attention to the general health, are oftentimes productive of encouraging results.

Necrosis.

Necrosis is death of bone. The dead portion, when thrown off as a superficial plate, is called an exfoliation ; when as a portion of the interior of the affected bone, a sequestrum. A case of new bone forms from the periosteum at the time the process of necrosis is being perfected within. Pus is discharged through openings in the sheath, termed *cloacæ*. Necrosis is most common in the

shafts of long bones, particularly the tibia, femur, and humerus, the articular extremities escaping. The disease commences with severe pain in the part, with heat and swelling. An abscess forms, which discharging, creates a sinus leading to the dead bone. Necrosis of the lower jaw may be occasioned by the fumes of phosphoric acid.

Fig. 367.



TREATMENT.—The surgeon should gouge away a portion of the bone case and remove the sequestrum through the opening thus effected. When an articulation is involved, amputation may become necessary. The constitutional treatment should be supporting.

Exostosis.

Exostosis is a product of localized hypertrophy. It commonly appears in the forms of nodules or spiculæ, generally upon long bones; and occasions, for the most part, but little inconvenience. If productive of any evil, the growth may be removed by the saw. Caution should be exercised in removing exostoses situated in the neighborhood of large articulations.

In those distressing cases of ivory exostosis of the face and skull, fortunately but rarely met with, operative procedure is, as a rule, unadvisable.

Mollities Ossium.

Mollities ossium (osteo-malacia) is a constitutional disease, characterized by the development of a morbid product, and softening of the osseous structure. The bones are light, breaking and bending readily. The organic constituents are in excess of the inorganic. The cancellated structure is filled with an oily substance intermixed with a reddish grumous product, which is composed of granular matter, nucleated, rounded, and caudated cells. The disease is rare, and commonly confined to aged females.

TREATMENT.—Supportive and palliative. No permanent relief can be expected.

Fragilitas Ossium.

Fragilitas ossium is a disease of bone due to the presence of excess of inorganic matter. Fracture follows upon slight causes, such as a trip in the carpet, or turning the body in bed. Although oftenest seen in advanced age—indeed, some degree of such a condition is characteristic of bones of old subjects—it occasionally occurs in the young, and may even take place in the body of the unborn child.

TREATMENT.—Perfect rest, with maintenance of the fragments in position. Union will at times readily occur; at others it delays, and in some instances never takes place. Tonics and alteratives, with generous support, are always indicated.

Rickets.

Rickets is a constitutional disease, marked by arrest of development of bone, with deficiency of its earthy salts and chemical change in its organic constituents. The bones are at first soft and flexible, the cancellated structure being filled with a yellowish oily fluid; but afterwards they become preternaturally hard and permanently shortened and deformed. When rickets proves fatal, the brain is found to be softened, the liver and spleen flabby, and the arteries occasionally partially ossified. It commences early in life. It is dependent upon the use of unwholesome food; and is often found in those having the scrofulous taint.

TREATMENT.—Improvement of the system by generous diet, pure air, iron, phosphates, etc. Mechanical apparatus to the limbs having a tendency to decurvation, and stimulation of the muscles by friction, are also of benefit.

Periostitis.

SYMPTOMS.—Hard, somewhat puffy swelling over a bone, not distinctly circumscribed, with pain.

Osteitis.

SYMPTOMS.—Constant, deep-seated pain in the part, with great tenderness of the limb. Chronic osteitis is often associated with elongation of the shaft of the bone.

TREATMENT.—Applications of leeches, hot fomentation, with exhibition of calomel and opium. In the chronic form, iodide of potassium internally, and repeated blistering. In periosteal inflammation free incisions down to the bone often markedly relieve the painful tension.

Osteomyelitis.

Osteomyelitis is an inflammation of the medulla. It is generally caused by direct violence, and is rarely seen in other than the long bones. It is of frequent occurrence after amputation in continuity, or resection of shaft. Exposure and previous disease predispose the system to osteomyelitis. It has been particularly noticed among soldiers who have been debilitated by the hardships of an active campaign. It shows a decided tendency to terminate in pyæmia. Two varieties are described—the acute and chronic. Acute osteomyelitis—the more frequent form—is recognized by arrest of suppuration in the wound, accompanied by pain, redness, and swelling of the part. In a short time the medulla protrudes from the bone in a button-like mass; the surface of the wound becomes sloughy; and symptoms of pyæmia are apt to set in. In the chronic form there is more evolvement of the osseous tissue. A sequestrum is very apt to form; while the sheath exhibits evidences of chronic inflammation.

TREATMENT.—In the acute form the stump should be relieved of all unnecessary dressing, a poultice should be applied, and the system vigorously supported. It is, however, very generally fatal. In the chronic form the treatment should be conducted on the same principles as those for necrosis and osteitis from other causes.

Coxalgia.

Coxalgia, or hip-disease, is a strumous disease of the hip-joint.

SYMPTOMS.—First stage, eversion of foot, with apparent elongation of limb and obliteration of the corresponding fold of nates. There is a slight pain referred to the knee, lameness, and pain in the socket when the head of the femur is forcibly brought in con-

Fig. 368.

APPEARANCE OF THE NATES AND LIMB IN COXALGIA IN ITS EARLIER STAGES.

Fig. 369.

SHORTENING, SWELLING, AND CHARACTERISTIC DEFORMITY OF THE ADVANCED STAGE OF COXALGIA.

tact with the acetabulum by striking the heel. In the second stage the foot is generally inverted, limb shortened, and thigh partially flexed. At this point anchylosis may occur in the hip and a cure may be effected, or a carious condition may set in, with

destruction of the acetabulum, formation of abscesses, and death by exhaustion may follow.

Treatment.—Perfect rest must be enjoined at the commencement of the disease. Later, in the treatment of the first stage, extension of the limb should be maintained. This is effected by means of weights (attached to the limb) pendent over a pulley at the foot of the bed. The extension can be kept up and yet the patient be allowed to move about by the application of the Davis' splint. This consists of a metallic support to the outer side of the affected limb, held in position by a perineal band above the joint, and circular straps around the thigh below. The degree of extension desired can be regulated by a screw adjustment upon the support. This apparatus may be worn during the day, but the weight is to be applied during the night. Spasmodic twitching of the limb, which retards recovery, may be relieved by dividing the tendons of the superficial abductor and gracilis and sartorius muscles. In the second stage, when anchylosis has taken place, the formation of a new joint, and correction of deformity by excision of the neck of the femur, have been effected with permanent success.

CHAPTER V.

INJURIES OF THE HEAD.

Contusion.

Contusion of the scalp may exist in various degrees, from a slight bruise to an extensively mashed condition of the parts, with cerebral complication. It is liable to be followed by inflammation, especially that of an erysipelatous form. The vascularity of the parts occasions great swelling and a sense of fluctuation beneath the finger; but on no account should the contusion be converted into a wound by an incision, for the parts in time may return to their natural condition by the blood becoming absorbed: should pus form, however, it should be at once evacuated. The induration following upon tumefaction is generally elevated at its margins while depressed in the centre, and assimilates the appearance presented by depressed fracture.

Treatment.—Every case of contusion, no matter how slight, should be treated with care. Premature exposure may lead to serious consequences. The parts should be bathed in cool or tepid water, and the bowels gently opened. The diet should be simple.

Wounds of the Scalp.

These may be *incised*, *lacerated*, or *punctured*. They are all followed by free hemorrhage, but as a rule result favorably. Bleeding from vessels of the scalp may always be arrested by *pressure* judiciously applied. Union may be expected by first intention, to

which end the detached portions, no matter how extensively lacerated they may be, should be washed of all dirt or other extraneous matter, carefully approximated, and united by the twisted metallic suture. Small wounds may be neatly closed by tying together small clumps of hair in the vicinity across the line of incision. It is rarely necessary to shave the scalp; should this, however, be deemed expedient, strips of adhesive plaster may take the place of the suture: or what, perhaps, is yet preferable, strips of gauze or soft linen stretched across the lips of the wound and collodion freely applied. Both contusions and wounds of the scalp may be followed by blindness, strabismus, numbness of the scalp, neuralgia, or even by epilepsy, and abscess of the liver.

Concussion.

Concussion, or stunning, is a shock transmitted to the brain, jarring its substance or interfering with its circulation. The force occasioning it may be direct, as from a blow upon the head, or indirect, as from the shock sustained in falling from a height and alighting upon the feet. The symptoms vary with the amount of injury received; when it is slight, there is simply confusion of ideas, with yawning and nausea, lasting but a short time; when it is more severe, nearly complete insensibility follows, with great prostration. The face is pallid, pupils generally contracted, though at times markedly dilated, respiration feeble, pulse rapid, small, compressible, the surface is cold; there is nausea, and inability to swallow. The bowels are relaxed; the urine is either retained or passed unconsciously, while the mind is dulled, being roused with difficulty, and general sensibility is obtunded. In this condition, which is recognized as that of collapse, the patient may lie from a few moments to many hours. Reaction sets in by restoration of the impaired functions. If brought on too suddenly, through incautious treatment, the pulse becomes full and strong, the face flushed, and violent headache with delirium follows. In order to obviate such an accident, the patient should, immediately after reception of the injury, be carried to a chamber, all compressing clothing being removed, while cautious efforts by dry friction are instituted to restore the circulation. If deglutition be at all possible, the administration from time to time of small quantities of some mild stimulant is advisable. Gentle excitation by means of smelling salts to the nose, warm water to the feet, are at times permissible; but the greatest care should be exercised in employing such remedies not to induce inflammation, since the impaired sensibility of the patient is a deceptive guide. Cold lotions may be applied to the head, and absolute quiet must be enforced. Bleeding in this stage is injurious, but in that of violent reaction it is a valuable aid in treatment, and may with benefit be employed both generally and locally. Opium is also useful, and may be conjoined with tartar emetic or veratrum viride in reducing the force of the circulation. After the reactionary stage has passed, danger is yet to be feared from a deceptive convalescence. The brain recovers slowly from its shock, while at the same time, the patient, feeling perfectly well, is apt to exhaust its already impaired functions by a too rapid return to active life. Violent inflammation is in this

way liable to recur, and death may be the penalty. The surgeon cannot be too guarded in giving an opinion with respect to this stage of convalescence, or too particular in his advice to the patient.

Compression.

Compression of brain is occasioned by the pressure of depressed bone, extravasated blood, pus, or more rarely of foreign bodies. Symptoms of compression are insensibility, almost always complete, pallor, and stertorous respiration. The eyes are fixed, pupils dilated, pulse full, soft, and slow, and the bowels torpid or relaxed. Conjoined to these symptoms there may be paralysis of the opposite side. When compression is immediate, it is commonly the result of depression of bone. When extravasation of blood is the occasion of the condition, it often ensues within a half hour from the inception of injury, or it may not come on until after reaction has set in. The blood very commonly comes from ruptured vessels of the pia mater, in which case the clot will lie within the membranes. It may also appear in the subarachnoid space, ventricle, or brain substance.

TREATMENT.—The loose fragments are to be removed; the depressed portions immediately elevated, or the skull trephined (see Fracture of Skull), while cold is applied to the head, and the bowels are freely opened. The patient is to be placed on low diet and removed from all causes of excitement.

For relief of compression from the presence of a clot no certain means present themselves. Should the clot be small, it may possibly in time be absorbed, but this is rarely the case, and the compression continuing is finally destructive of life. The application of the trephine invites but little encouragement, for there are no means of ascertaining the exact locality of the clot, or even, if fortunately removed by this means, of preventing its recurrence. Compression from formation of pus is of later date than that from other causes. Generally a week or fortnight, or even a longer time, intervenes between the time of injury and that of its formation. The fluid may exist between the dura mater and skull, or, as is more often the case, in the substance of the anterior or middle cerebral lobes. It is apt to be associated with effusion. Cerebral abscess occasionally arises from blows to the skull insufficient to fracture it. Trephining presents the only means of cure of this. The instrument should be applied over the seat of original injury with the hope of disclosing the purulent collection. When the pus is known to be located within the brain itself, an attempt to reach it by incision is justifiable.

Fracture of the Skull.

Fracture of the skull is of frequent occurrence. It is commonly occasioned either by direct violence or by a shock transmitted through the spinal column. Fractures of the skull are arranged for convenience into two groups. Fracture involving both plates of the skull, such as simple fractures, and compound fracture; and fractures involving one plate only. In simple fracture the skull is either fissured, or there is depression of both tables at the site of

injury. In the latter instance symptoms of compression are likely to follow.

Fracture of either table alone is extremely rare, and can occur only in the adult in whom the diploic structure is developed. Lesion of the inner table is the more serious of the two varieties. It is generally the result of contusion from a bullet or some similar missile, and the depressed fragments of the inner table are always larger than the contused area without. Early trephining affords the only means of cure.

Compound fractures are recognized when the scalp is wounded admitting air to the parts involved. They may be either fissured, depressed, or comminuted. The degree of violence requisite to create a compound fracture often produces the latter form, and the consequent dangers of extensive lesion ensue. The more conspicuous of these are shock from which the patient may never recover—inflammation, which may rapidly extend itself over the membranes of the brain—and after its subsidence, or associated with it, protrusion of the brain substance.

A fracture at the base of the skull is either simple or compound. It is the result of a fall from a height, the force of the blow being received upon the vertex. The vault of the cranium may escape while its base is extensively fissured. The petrous portion of the temporal bone, the ethmoid bone, and the basilar process of the occipital bone, are frequently the sites of injury. The symptoms are those of concussion and compression, which come on rapidly and commonly are persistent.

Hemorrhage, either in the form of ecchymosis, as around the eye, or at the pharynx, or free bleeding from the nose, mouth, and ears, is not uncommon. There is often seen flowing from the external ear a quantity of serous fluid, varying in quantity from a few drachms to five ounces daily. This is supposed to be derived from the subarachnoid space, and is one of the most marked symptoms of the lesion. The accident is almost always fatal. No means of arousing the sufferer are effectual. The treatment should be that of concussion and compression.

A punctured fracture is the result of a wound received from a dirk, piece of brick, bayonet, etc., penetrating the skull, and depressing both tables. The injury is apparently slight, though in reality serious. The propriety of trephining may be so apparent that the operation is to be performed at once, even though there be no decidedly untoward symptoms. But in whatever manner the skull may be injured, a prognosis should be cautiously given. Death often follows simple, undepressed fracture—abscess of the brain may ensue upon a contusion of the vertex. On the other hand, recoveries have occurred where great comminution of skull with loss of brain substance has been sustained.

Gunshot wounds of the head are not always, though generally, fatal. A bullet may pass around the skull without penetrating it; or it may pass through some parts of it without wounding the brain. No *search* for a ball is proper in the head, chest, or abdomen; but any foreign body, when discovered and accessible, should be removed.

Owing to the semi-membranous condition of the bones of the

vertex of young subjects, the force which would produce fracture in the adult here results in depression. Instances of this kind, creating extraordinary deformity, are on record. As a rule, such

Fig. 370.

Wound of Entrance.

Fig. 371.

Wound of Exit.

cases do well, the resiliency of the parts involved in a short time restoring the natural contour of the skull, with relief of all symptoms of compression.

Trephining.

The conditions requiring this procedure may be summed up as follows :—

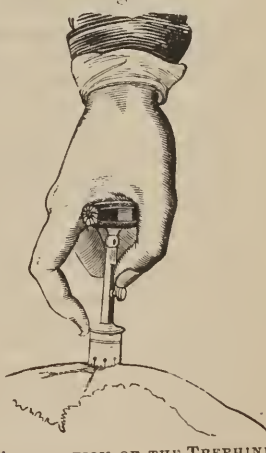
"1. Simple fracture with depression when the symptoms of compression persist after medication.

"2. Compound fracture with depression, without symptoms of compression.

"3. Punctured fractures.

"4. Extravasation of blood, formation of pus, epilepsy."—(Gross.)

Fig. 372.



APPLICATION OF THE TREPHINE.

The operation is performed, after the scalp is shaved, and the patient placed upon a table in the recumbent posture, by a crucial, T-shaped, V-shaped, or semicircular incision (the choice being determined by circumstances), made over or near the site of injury, down to the bone. The flaps are then drawn to the sides of the wound and carefully protected during the subsequent stages of the operation. In cases of compound fracture, before the instrument is applied, depressed fragments should be removed by the elevator, and any sharp angle of bone removed with the Hey's saw. These preliminary steps having been taken, the crown of the tre-

phine is placed upon the desired spot (Fig. 372), avoiding the direction of the large venous sinuses and the great meningeal artery, and a semirotary motion alternating from right to left and from left to right is effected, the pin within the crown having previously been slightly extended beyond the sawing surface. As soon as a fair lodgment is effected the pin is withdrawn to avoid injury to the meninges, but the to-and-fro motion is continued until the entire thickness of the bone is traversed. The sawdust should be removed from time to time from the wound with a brush, and its depth occasionally ascertained by a toothpick. Care must be taken when approaching the brain to exert no pressure upon the instrument, and to so manipulate it as to effect division of the inner table simultaneously at all points. In trephining over the frontal sinus, which should if possible be avoided, the outer opening is to be made larger than the inner. Trephining is resorted to only under the most desperate circumstances. The mortality from the operation is in consequence very great. In the hospitals of Europe, it is reported, it is almost invariably fatal. In this country, it is estimated to be fatal in three out of every four cases. But in spite of these fearful results the trephine in the hands of the judicious surgeon is an invaluable instrument, and has doubtless saved many lives.

CHAPTER VI.

AFFECTIONS OF THE EYE.

Diseases of the Eyelids.

Hordeolum or *stye* is a small boil situated at the edge of the eyelid. It oftener occurs in the young than in the old, and in the female than in the male. Persons of a strumous constitution are prone to the disease. It is frequently accompanied by disorder of the digestive organs.

Treatment.—When merely threatening to form, a stye may sometimes be dissipated by the gentle but repeated application of ice to the part. If this fail, then suppuration should be encouraged by warm fomentations. Pustules should be opened as soon as formed. Regulation of the diet is the best preventive.

Ophthalmia tarsi, or inflammation of the eyelids, is most frequently met with in a subacute or chronic form. It is commonly seen in scrofulous children, in whom the lids become red and thickened, and muco-purulent matter accumulates at the roots of the lashes. The eyelids are glued together in the morning. There may be an excessive flow of tears, or the eye may become dry, especially towards evening. The lashes often become loose and fall out; or may be turned inward (*trichiasis*), irritating the conjunctiva.

Treatment.—This consists in the removal of all sources of

irritation; by warm fomentations to the lids, and application of carbonate of lead, diluted red precipitate, or citrine ointments. Iodide of potassium or syr. iodide of iron internally is found useful. A few drops of the solution of sulphate of atropia, gr. ss—gr. j to the ounce, will temporarily relieve the photophobia.

Entropion.

Entropion, or inversion of the lids, is the result of chronic granular conjunctivitis, attended by intolerance of light. This produces frequent spasmodic contractions of the orbicularis palpebrarum muscle, the inner fibres of which are liable to turn the free edges of the tarsal cartilages upon themselves. The eyelashes thus excite constant irritation of the conjunctiva, resulting in inflammation and corneal opacity.

TREATMENT.—When inversion is dependent upon laxity of the tissues of the lid, the external application of collodion is at times sufficient to effect a cure. When, however, it follows upon granular conjunctivitis of long standing, the removal of an elliptical portion of the skin of the affected lid, and the union of the edges of the wound by suture, is the best operative procedure.

Ectropion.

Ectropion, or eversion of the lids, may arise either from inflammation (when it is owing to excessive contraction of the inner fibres of the orbicularis with a relaxed condition of the lids), or from burns or wounds. The former variety is amenable to the treatment for inflammation; the latter requires operative interference, which consists in freeing the lid from its cicatricial attachments, and excising a flap of its redundant tissue.

Ptosis, or inability to raise the upper lid, may be dependent upon inflammation in traumatic injury, or upon paralysis of motion.

TREATMENT.—Varies with the nature of the disease. Electricity, tonics, and stimulating applications are indicated for the forms originating from idiopathic causes. When the lid falls from enlargement, or from induration, an elliptical portion of the integument may be excised.

Obstruction of Lachrymal Duct.

The ductus ad nasum, by chronic inflammation of its walls, or by the presence of inspissated mucus, or a detached eyelash, may become partially or completely closed. As a consequence the tears collect in the lachrymal sac at the inner canthus, from which on pressure they appear through the puncta. Inflammation is apt to follow, and to terminate in an abscess, which opens through the skin. The opening after the free exit of pus may gradually close, though most generally (owing to the persistence of the obstruction, more particularly if it be associated with disease of the bones, or nasal polypus) it remains open. Lachrymal fistula, as the disease is now called, is recognized by the presence of a minute opening beneath the tendon of the orbicularis muscle, surrounded by a bluish-red areola. The tears constantly flow over the cheek,

the eye is subject to more or less irritation, and the sac itself is liable to be the seat of repeated abscesses.

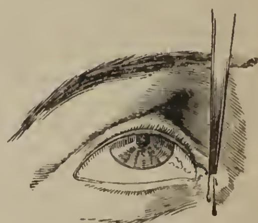
TREATMENT.—When the obstruction is dependent upon chronic inflammation of the duct, it should be met by local applications of dilute tincture of iodine; while attention is paid to the general health. When, however, the calibre of the duct is constricted by the product of inflammation, its dilatation by instruments presents the only means of relief.

A permanent style may be introduced into the canal by opening the sac from above. To perform this operation, the patient sits

Fig. 373.

A STYLE, OR SHORT PROBE.

Fig. 374.



OPERATION FOR OPENING LACHRYMAL SAC.

upon a chair, with his head supported upon the breast of the surgeon. Making the tendon of the orbicularis tense by pulling upon the outer angle, a straight bistoury (Fig. 374), with its cutting edge directed outwards, is passed beneath the tendo oculi obliquely downwards and inwards. Then by bringing the handle inwards and forwards, the duct is entered. The style (Fig. 373) which should have an extended top to prevent it falling into the nose, is then inserted into the duct at the same time that the knife is withdrawn. This procedure failing to effect a cure, obliteration of the sac by cauterization may be advisable. Slitting up the lower lachrymal canaliculus upon a director, permitting ready passage of probes of different sizes into the nasal duct, is an operation which has recently met with favor.

Strabismus.

Strabismus or squint is a want of parallelism in the position and motion of the eyes. It may be dependent upon disease of the brain, but is most generally a local disorder due to paralysis of the antagonizing muscle, or spasm of the one immediately involved. The eye may be turned inwards (convergens), outwards (divergens), upwards, or downwards. The first two named are the more common forms.

TREATMENT.—Consists in cutting the tendon of the contracted muscle causing the aberration. If the operation be for internal strabismus, a fold of conjunctiva, in about the position of the

semilunar fold, is raised by means of a pair of fixation forceps, in such a manner that the elevated portion will be oblique to the line of the caruncle. Care being taken to secure the subconjunctival connective tissue in the blades of the forceps, the fold is freely divided by a pair of blunt-pointed scissors. The tendon of the muscle is then drawn out upon a blunt hook, and its division effected by the scissors. The operation for divergent strabismus requires a freer division of the conjunctival tissues. The after-treatment consists in bathing the eye in cold water, and enforcing rest for a few days. The lids may be closed by isinglass plaster.

Conjunctivitis.

Conjunctivitis, ophthalmia, is recognized by the injection of the sclerotic and the uniform redness of the palpebral conjunctival linings. The membrane is swollen, especially the ocular portion, while the lids are red and tumefied. Lachrymation, intolerance of light, and a sensation as though there was sand in the eyes, are generally constant symptoms. The pain is slight, except in some cases, when it becomes marked. The altered character of the secretion of the conjunctiva may vary from that of a watery fluid to a decided muco-purulent discharge.

Treatment.—Perfect rest of the affected organ, with application of a solution of nitrate of silver, gr. ij to gr. v to the ounce, with cold cream or ointment of carbonate of lead applied to the lids at night to prevent their adhesion, generally suffices to cure the milder forms of the disease. In cases accompanied by constitutional disturbance, the treatment may be commenced by mild purgation, and inducing free action of the skin. Counter-irritation and local depletion are rarely called for.

Purulent conjunctivitis is a term applied to those forms of ophthalmia accompanied from the first with a profuse purulent discharge. The conjunctivitis of new-born children is of this type. The eyelids become greatly swollen and closed. The conjunctiva is much tumefied, the cornea is liable to become opaque and to ulcerate, while the pain is extreme. The ophthalmia of tropical countries, Egyptian ophthalmia, may appear epidemically, and is seen in its most violent form in bivouacs and crowded cities. In addition to the symptoms above described, it presents a marked tendency to ulceration, softening, and gangrene. Its ravages, under favorable conditions for its development, are frightful, many dying of the disease, and the majority of the survivors becoming permanently blind.

Gonorrhœal ophthalmia is a phase of conjunctivitis observed in patients affected with gonorrhœa, and is believed to be caused by the inoculation of the eyes with the specific urethral discharge. It is sometimes associated with rheumatism.

Treatment—must be active. Application to the eye of strong solutions of nitrate of silver, ten to thirty grains to the ounce, with cooling lotions, such as white of raw egg, solution of elm bark, alum curd, etc., are the local remedies relied upon. The purulent matter should be prevented from accumulating within the lids by the frequent injection of tepid water or milk, by means of a syringe. The general strength must be supported by tonics, nutritious diet,

and moderate stimulation. The discharge is inoculable, and care should be taken not to transmit the disease to other patients.

Granular inflammation (granular lids) is due to the roughened condition of the palpebral conjunctiva, dependent upon the presence of minute elevations. These resemble the granulations of an ulcer, but in reality are villus-like growths of the membrane itself, or, in its chronic forms, a nodular condition of the sub-conjunctival layer. They are more abundant upon the upper than the lower lid, and are liable, if neglected, to occasion permanent loss of sight, by rendering the cornea opaque.

TREATMENT.—If the granulations be exceedingly abundant, evert the lid, and apply upon the surface thus exposed the solid stick of sulphate of copper. The case should be treated as one of simple conjunctivitis. Strong solutions of nitrate of silver, or the employment of the sulphate of copper alone, suffice for the cure of milder cases. Scarification of the lids is productive of temporary relief. External application of ointment or cerate of carbonate of lead may do considerable good. In the event of failure from these methods, the use of liquor potassæ may prove efficient. Drinking spirituous liquors and smoking tobacco must be strictly prohibited. The disease is very intractable and liable to recur.

Symblepharon.

Symblepharon is union of the eyelid to the eyeball, the result of cicatrization. Relief is obtained by an operation consisting in separating the adhesions covering the open surface by a stitch in the conjunctiva, while the detached tissue is drawn outward, and made to unite at the canthus through its retention there by ligature.

Sclerotitis.

Sclerotitis, or inflammation of the fibrous coat of the eye, is rarely seen uncomplicated with other disease. It is often of a rheumatic or gouty nature. It is recognized by acute deep-seated throbbing pain and photophobia, by the bluish, pink, or lilac appearance of the sclerotica, and by the fixed minute vessels which radiate in parallel lines from the cornea. The inflammation is accompanied by increased flow of tears, to which, at times, a mucoid discharge is added. The eyelids are rarely involved. Chronic sclerotitis keeps close to the corneal margin. It is generally of rheumatic origin.

TREATMENT.—Constitutional tendencies should be early recognized, and met accordingly. Simple sclerotitis is treated by anodyne applications, such as a liniment of chloroform and olive oil, or ointment of belladonna, around the eye, and steam of water direct to its ball.

The exhibition of opiates, purgatives, and the induction of diaphoresis, are often indicated.

Corneitis.

Corneitis, or *keratitis*, is recognized by a superficial zone-like layer of enlarged vessels at the edge of the cornea, and a cloudy hue

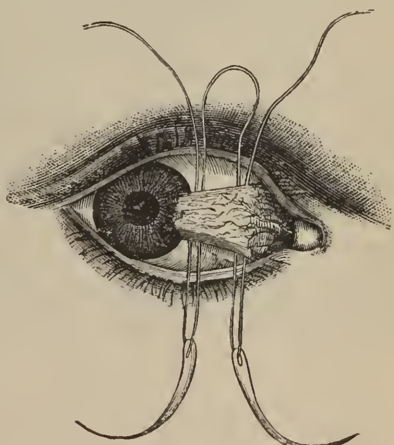
of the whole texture. It may run on to purulent infiltration (onyx), and subsiding, leave opacity and ulceration as sequelæ; or pus may enter the anterior chamber of the aqueous humor, when it is called *hypopion*. It is often symptomatic of hereditary syphilis, when the vascular engorgement is more marked and deeper seated. This variety is constantly associated with an imperfect development of the enamel of the teeth, particularly that of the incisors, which present contracted crowns and notched edges.

TREATMENT.—Same as in the above acute affections of the eye. Corneal abscess may be punctured. Opacity is met locally by weak solutions of nitrate of silver and sulphate of atropia, sulphate of cadmium, or a weak ointment of the oxide of zinc. Internally, chalybeates and iodide of potassium are indicated.

Pterygium.

This is a growth upon the conjunctiva, mostly fan-shaped, between the nasal side of the surface of the eye and the cornea, over a part of which it may extend.

Fig. 375.



TREATMENT.—*Excision* or dissection away from its base; or removal by *strangulation* by means of two or three ligatures; or *transplantation* of the corneal end, which is turned back and fixed in an incision of the lower portion of the conjunctiva by means of a delicate suture.

Staphyloma.

Staphyloma, an enlargement of the cornea, and its protrusion beyond the eyelids, may be the result of inflammation or hypertrophy. In the latter case, it is symmetrical. It is of two forms, conical and spherical. Staphyloma or prolapsus of the iris also may occur.

The palliative TREATMENT is discouraging. Sometimes the projecting part may be removed by excision, strangulation, or seton. When fully formed—the sight being frequently destroyed—the patient is made more comfortable by partial excision of the eyeball.

Arcus Senilis.

Arcus senilis is fatty degeneration of the margin of the cornea. It is found in old persons, and is often accompanied by similar changes elsewhere. There is no cure.

The Ophthalmoscope.

For the appreciation of diseased conditions of the interior of the eye a knowledge of the use of the ophthalmoscope becomes necessary. The instrument is a contrivance by whose aid the dark background of the eye may be lighted up, and its delicate tissues accurately inspected. The instrument invented by Dr. Anagnostakis is the one most commonly employed in this country. "It essentially consists of a lens and of a concave circular mirror, about two inches in diameter, perforated in the centre by a small hole; to the back of which is fitted a plate of blackened copper, the whole being inclosed in a brass ring and mounted upon a short handle." —(Gross.) "In order to effect a satisfactory examination of the eye with the ophthalmoscope it is essential to have a good light. Artificial light, as that from an oil or gas lamp, is practically the best. In preparing the patient for an examination, the pupil should be dilated by atropia: a small quantity of a solution containing one-twentieth of a grain of the alkaloid to the ounce of water having been applied to the eye several hours before. The room being darkened and the patient seated, the lamp should be placed near the head of the patient, on the same side as the eye to be examined, so far back as to leave the cornea in shadow. It is also important that the flame, the eye of the patient, and the eye of the observer should be all at the same level. The observer now takes the concave mirror in the hand that is on the side towards the lamp, places its edge against the superior margin of his orbit, and looks through the perforation at the eye to be examined; he then causes the mirror to turn a little on its vertical axis, until the inverted image of the flame is cast upon the eye under examination, the pupil of which will then return a more or less intense reddish or whitish glow. For a general inspection of the refracting media, it will be sufficient to look at the eye from different directions and cause it to make slight movements upwards, downwards, and to either side. If no diseased conditions be apparent, the observer proceeds to examine the inverted image of the fundus. For this purpose he takes a biconvex lens of 2″ or 3″ focal length, in the thumb and index of his free hand, rests his little finger upon the forehead of the patient, and brings the lens in front of the examined eye, so that the light from the mirror, passing through the lens, will be concentrated upon the pupil. The actual inverted image of the fundus will now be formed betwixt the lens and the eye, and in the focus of the former; and to render it

Fig. 376.

LIEBREICH'S OPHTHALMOSCOPE.

visible, the observer must usually move his head somewhat farther back. The first object to be sought within the eye is the entrance of the optic nerve. Sometimes before its white surface becomes visible, darker streaks may be seen traversing a bright red ground.

Fig. 377.

These will be the vessels that proceed from the entrance itself, and by following one of them, in the direction of its increasing thickness, towards the inner and inferior parts of the eye, by movements of the observer and mirror in the opposite directions, the white surface of the optic-disk will presently be perceived. After inspection of the nerve surface, attention should next be directed to the vessels, to observe whether they present a normal condition at their place of entrance, to note their course over the white disk, and their conduct at and after passing to the red background. After the vessels, should be observed the transparency of the retina, its relations to the choroid; and then the observer should return to a more careful and accurate study of the entrance of the nerve. Lastly follows the inspection of the refractory media, the vitreous body, the crystalline lens, the cornea, and then that of the iris."—(Zander.)

Iritis.

Iritis is apt to commence insidiously. Slight pain and intolerance of light are early symptoms, followed by diminution in size and change of form of the pupil, owing to its adhesion at one point to the capsule of the lens and its irregular dilatation at another. Sulphate of atropia is useful in aiding us to detect this condition. The iris is of a faint rose or deep cinnamon color. The sight is impaired. The pain is worse at night. Idiopathic iritis is often of syphilitic origin.

TREATMENT.—The pupil should from the first be dilated with atropia. For this, a solution of from two to four grains in the ounce may be dropped into the eye thrice daily. Local depletion from the temples by leeches, and the use of warm fomentations, are also recommended. Mercury pushed to slight ptyalism is recommended by some, at least in *syphilitic* iritis. After the acute symptoms have subsided, iodide of potassium should be given in two to five grain doses three times a day. When the iris by inflammatory change has become permanently contracted, the operation of iridectomy may be performed. This consists of opening the anterior chamber of the eye through the cornea, drawing out, by means of a delicate hook, a portion of the iris, and effecting its excision by the scissors.

Cataract.

Cataract is "an opacity of the crystalline lens, of its capsule, or of both." The first is called lenticular, the second capsular, and the third lenticulo-capsular : the last named is the most common. Cataract exists at any age, and may even be congenital. But it is most commonly met with after the fifteenth year. Cataract is generally whitish with varying shades, in different cases, of grayish, yellowish, and greenish ; the capsular form is apt to be lighter than the lenticular. It varies in consistency from a milk-like fluid to the consistency of cartilage—hence we have *hard* and *soft* cataracts. The former are bulky, of a light color, apt to be recent, not commonly symmetrical, and generally seen in subjects under fifty years of age ; the latter are small, of an amber color, and of long standing. A patient with cataract sees objects dimly ; better in subdued than bright lights, owing to the pupil being dilated under the former condition. By the use of the catoptric test, which consists in holding a lighted candle before the suspected organ, the examination being conducted in a dark room, the presence of a cataract can be with certainty determined. If the cornea and lens are unaffected, three images of the flame are seen : the first on the cornea, the second on the anterior surface of the lens, and the third on the concave surface of the posterior wall of the capsule. The second of these is *inverted*, and is entirely absent in cataract, while the third image is indistinct. The degree of opacity can be best determined by means of oblique illumination by artificial light. Cataract is distinguished from amaurosis by the dimness of vision coming on slowly, by the pupil responding to light, by the eye retaining its expression, by

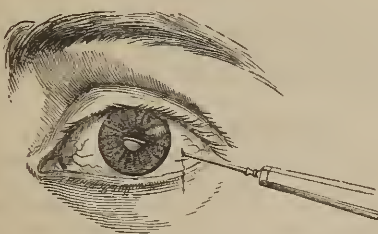
the absence of hemicrania, and by the negative signs obtained with the ophthalmoscope.

TREATMENT.—Three operations for cataract are proposed : 1st. *Laceration.*—This is performed by Hays' knife-needle (Fig. 378), which is inserted two and a half lines behind the cornea and below the horizontal diameter of the eye, directed forwards in front of the lens and its capsule, which is ruptured and the lens freely divided. Its fragments fall into the anterior chamber and are dissolved by the aqueous humor. This operation is especially adapted for soft cataract. 2d. *Couching.*—This consists in pushing a spear-shaped curved needle across the coats of the eye two and a half lines behind the cornea, and carrying it in front of the cataract (Figs. 379, 380). The lens is then pressed downwards and backwards into the vitreous humor below the axis of vision. The presence of

Fig. 378.

HAYS' KNIFE-NEEDLE.

Fig. 379.



DEPRESSION OF CATARACT.

the displaced lens often acts as a foreign body in its new position, and sooner or later appears unchanged in its old place, or induces destructive retinitis. This operation is now but little practised. 3d. *Extraction.*—This is performed by Beer's or Von Graeffe's knife, which is inserted into the sclerotica one-twentieth of an inch from the cornea, the blade being kept on a plane with that of the iris. The knife is then pushed across the anterior chamber, and a corneal flap effected. The incision may be made either upwards or downwards, the latter, in the opinion of many surgeons, being preferable. The anterior wall of the capsule of the lens is then ruptured, by means of a delicate narrow-shanked knife —the capsulatome—when by gentle pressure upon the eyeball the lens slips out, or, what, perhaps, is better, is extracted by means of the scoop, and removed through the corneal opening. The operation of iridectomy is ordinarily practised before incising the capsule. Von Graeffe's last operation was that of *modified linear extraction*, without a flap, the incision

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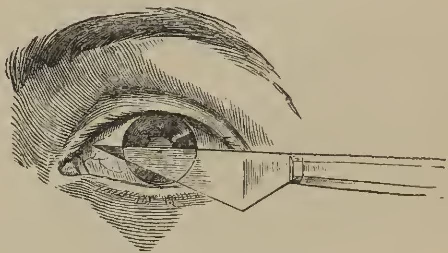
being made in the line of the curve of the eyeball. A vulcanite or tortoise-shell spoon is used to favor the escape of the lens, rather by pressure than traction. This is perhaps the best operation for hard cataract, though the most difficult to perform. After

Fig. 380.



SECTION OF THE CORNEA.

operation for cataract the lids should be closed with isinglass plaster, a quantity of lint placed over the eye, and a light bandage applied. It is good practice not to remove the dressings until the fourth or the fifth day.

Amaurosis.

Diseases of the inner tunics of the eyeball were, prior to the discovery of the ophthalmoscope, confounded under the name of amaurosis. Retinitis, choroiditis, fatty and pigmental degenerations, retinal dropsy, and many other diseases now known to be distinct, were here included. In many the symptoms are not well defined, and the morbid condition is recognized only by its objective signs. In some acute forms of retinitis and choroiditis, however, the rational signs are more prominent. In the former there are at times local pain, excessive intolerance of light, scintillations—flashes of light, and luminous grotesque objects floating before the vision. The pupils are contracted in the early stage, but become widely and permanently dilated as the disease is established. The disease is met with among persons habitually employing their eyes in the examination of minute objects, as watchmakers, microscopists, etc. In choroiditis there is less perception of luminous objects, the pain is dull and throbbing, and is apt to radiate in various directions, but more particularly towards the base of the brain. The iris is contracted irregularly, the eyeball is injected. Choroiditis is met with among students and literary men. Both forms of inflammation have a tendency to induce blindness, which indeed is too often the termination of all amaurotic affections. Nothing special needs to be said of their treatment. Antiphlogistics, when acute, or alteratives and tonics when chronic, with attention to hygiene and diet, are the main features. In the chronic forms the prognosis is unfavorable. Temporary blindness, as temporary strabismus, may accompany some intestinal irritation, and subside with the removal of the cause. *Amblyopia* is dimness of

vision approaching amaurosis. *Asthenopia* is *weak sight*, partial blindness following continued use of the eyes in looking at the same or similar objects, as in reading, writing, etc. It may depend upon fatigue of the muscles of *direction* of the eyeball, or of *accommodation*, or upon exhaustion of the sensibility of the retina or optic nerve.

Glaucoma.

Glaucoma is the result of a morbid process affecting all the tissues of the eye. It is characterized by an abnormal hardness of the eyeball, by formation of plastic matter upon the retina and choroid membrane, and their subsequent atrophy and softening. The symptoms are flashes of light, persistent pain, gradual impairment of vision, haziness and flattening of cornea, loss of contractility of iris, the pupil being permanently dilated, and of a grayish or grayish-green color. The lens may become cataractous.

Treatment.—The operation of iridectomy should be performed early in the disease. About one-sixth of the entire curtain should be removed, through a corneal incision. The pain and tension decrease, and the progress of the affection is for the time checked. No prospect of cure can be entertained.

Other terms in ophthalmology which require here to be only defined, are the following: *Emmetropia* is normal accommodation of sight; *Myopia*, near-sightedness; *Hypermetropia* (presbyopia), long-sightedness; *Astigmatism*, unequal refraction in different parts of the eye; *Hemeralopia*, day-sight or night-blindness; *Nyctalopia*, night-sight or day-blindness.

CHAPTER VII.

DISEASES AND INJURIES OF THE EAR.

Wounds.

In wounds of the external ear hemorrhage may be free. Compression is here more effectual than ligation. If the cartilage be cut, care should be taken to properly adjust the parts to prevent the formation of a permanent slit.

Foreign Bodies.

Foreign bodies and accumulation of wax in the external auditory tube are best removed by gently syringing with warm soapsuds. Occasionally the employment of a loop of fine silver wire may be requisite, care being observed in protecting the membrane of the tympanum from injury. To destroy insects, oil or mucilage should be poured in the ear, and the intruders may be afterwards removed by the syringe.

Tumors—Otorrhœa.

Erectile tumors may be removed by caustics—chromic acid being the agent commonly preferred. Polypi are best treated by strangulation. *Otorrhœa* generally depends upon an ulcerated tympanic membrane, and is apt to occur in young subjects of scrofulous parentage. The discharge is yellowish, of a creamy consistence, and has a peculiar offensive odor; the hearing is dull. As a rule there is freedom from pain. In children, the morbid action, when excessive, is at times conducted to the meninges of brain, and death from this cause or from pyemia may ensue.

TREATMENT is palliative. Injections of chlorinated soda, or solution of permanganate of potassium, should be freely used to correct the fetor; and attempts may be made by application of nitrate of silver to the parts to promote reparative action. Supporting remedies, as cod-liver oil, iodide of iron, generous diet, etc., are almost always indicated.

Deafness.

Deafness may arise from disease of the nerve of hearing, or from a variety of causes obstructing or destroying the external or middle ear. These causes are due either to direct injuries or to diseased action. Among the more common of the latter group may be mentioned caries and necrosis of the temporal bone, chronic inflammation of the middle ear and Eustachian tube, and destruction of the membrane of the tympanum.

The TREATMENT depends upon the nature of the cause. Nervous deafness is believed to be incurable; deafness due to caries may be alleviated, though never entirely cured; that from loss of tympanic membrane may in a measure be relieved by the use of an artificial substitute; that from thickening from chronic inflammation unaccompanied with structural change is more amenable to medication, and by judicious employment of mild astringent solutions thrown up into the ear by the Eustachian tube, the accumulations of mucus may be removed and a healthy action may be set up in the tympanic mucous membrane. Eustachian catheterism consists in passing along the tube a peculiarly constructed catheter, either for removing strictures or as a means of throwing fluids more readily into the chamber of the middle ear.

CHAPTER VIII.

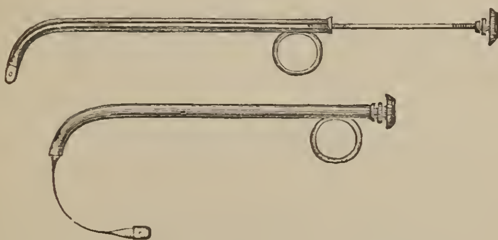
DISEASES AND INJURIES OF NOSE AND FACE.

Epistaxis.

BLEEDING from the nose is produced by injury, plethora, or a diseased state of the mucous membrane. It can generally be arrested by cold water freely applied to the parts as well as to the head and nape of neck; or local application of solutions of tannin,

alum, or persulphate of iron. These means failing, the nostrils should be plugged, both anterior and posterior nares being by this means completely closed. Bellocq's canula should be used in serious cases, in order to apply a plug of lint, cotton, or sponge to the posterior nares. It is threaded with a looped ligature and passed through the nostril till the loop can be seized in the mouth, and the plug fastened to it and drawn back against the palate. Then the instrument may be withdrawn, and the anterior ends of the ligature may be secured together. As a rule the plugs

Fig. 381.



should not be allowed to remain over forty-eight hours, to avoid inflammation and disturbance of the system from the remains of the hard clot. A patient having lost much blood must be enjoined to maintain the recumbent posture.

Foreign bodies, such as peas, beans, beads, buttons, etc., are frequently thrust into the nasal cavity by children. They invariably excite more or less irritation as long as retained. They are, for the most part, readily removed by exploring instruments, after all clots of blood have been removed by careful syringing. If, however, the offending body cannot be seen, the sneezing excited by a pinch of snuff will often discharge it.

Polypus.

Polypus of the nose is of two kinds : gelatinoid, and fibrous. The former of these is the more common. It is of a whitish color, and spongy consistence, resembling an oyster, pendulous in the majority of instances from the superior turbinated bone, and is covered by a prolongation of the mucous membrane. It may exist simultaneously in both nostrils. The latter form is generally found situated farther back in the nasal cavity, is less movable than the gelatinoid, and is of a deep red or purple color. It is occasionally seen growing from the mucous membrane of the pharynx, having firm attachments to the base of skull, and is apt to assume malignant features. Polypus is attended by a sense of fulness about the nose, difficulty of breathing when the mouth is closed, snoring ; and, in its advanced stages, lachrymation, partial deafness, and giddiness.

Treatment.—The gelatinoid polypus can be removed by torsion of its pedicle by a pair of slender curved forceps introduced through the anterior nares. It sometimes becomes difficult to

find the attachment, when the mass must be torn away piecemeal. Removal of the fibrous polyp is more difficult and apt to be accompanied with troublesome hemorrhage. Partial resection of the superior maxilla may become necessary. Malignant polypus, as a rule, is not amenable to treatment.

Ozæna.

This is a profuse discharge from the nose, having a peculiar fetor. It is always associated with diseased conditions of the lining mucous membrane, and is very commonly the result of a scrofulous or syphilitic taint. Ulceration often coexists, and in chronic cases the nasal septum and turbinated bones become involved. The supports of the nasal arch are thus impaired, the nasal bones become depressed, producing permanent deformity. The disease may occur either in the young or adult.

TREATMENT is palliative. Stimulant and slightly astringent washes are employed to correct the ulcerative tendency; and when the seat of disease can be detected, topical use of nitrate of silver to the edges of the ulcers may be resorted to, either in strong solution or the solid stick. The fetor, which renders the patient disgusting both to himself and to those about him, is best allayed by injections of mild solutions of chlorinated soda, or permanganate of potassium. Constitutional remedies, such as cod-liver oil, preparations of iron, and iodine, are of equal importance with local ones.

Diseases of Antrum.

Dropsy of the antrum, so called, is a retention of mucus in the antrum, producing deformity by raising the floor of the orbit, depressing the roof of the mouth, and inflating the side of the face; the parts are indolent, semi-elastic, and crackle under pressure.

TREATMENT.—Perforate the sinus at its most dependent, prominent part, and after the escape of its contents insert a pledget of lint to prevent premature closure.

Suppuration is often caused by the fang of a carious tooth pointing through the floor of the chamber. There is throbbing, lancinating pain; and small quantities of pus occasionally passing into the nose give rise to an offensive discharge. The offending tooth should be extracted; if the opening thus created be not sufficient, the cavity must be perforated through the alveolus, or from without, immediately above the second molar. Discharge of pus is facilitated by syringing with warm water.

Tumors of the antrum may be enucleated by partial excision of the superior maxilla. When the bone itself is extensively involved, its entire extirpation may become necessary. The operation generally performed is removal of the bone by separation with forceps at the malar and palatal region; space being secured for manipulation by a flap of the cheek defined by a curvilinear incision extending from the angle of the mouth upwards and outwards to the zygomatic process. When necessary, this may be met by one extending horizontally beneath the orbit. Some authorities, to avoid dividing the facial nerve, prefer an incision made through the median line of the upper lip, circumscribing the nose to reach

the inner edge of orbit. Difficulty is often experienced in detaching the palatal extremity. This is best overcome by depression of the detached mass, while it is held for the purpose in a pair of stout toothed forceps.

Epulis.

This, one of the most frequent of the tumors of the mouth, is generally found upon the gum of the lower jaw, rarely being met with upon that of the upper. Generally of a fibrous nature, it may be hæmatoidal, and occasionally malignant. It presents a rounded, generally pedunculated tumor, of moderate size, somewhat elastic, but firm. It appears to be a product of the gingival tissue, though usually supposed to originate from the socket of a tooth. It manifests a strong tendency to recur.

TREATMENT.—Consists in removing the mass, together with involved teeth, by two vertical incisions, met by a horizontal one below the level of the alveoli.

Cystic Disease.

Cystic disease of the lower jaw is a comparatively rare affection, and is more often seen in the adolescent than in the adult. The cyst may be single or multiple, and is generally placed upon the alveolar region. At times it occupies the position of the angle and ramus, where it has been mistaken for parotid tumor.

TREATMENT.—Break down the walls of the cyst by pressure, and give exit to the contained fluid by small incisions. The disease is not liable to recur.

Alveolar Abscess.

Suppuration about the root and socket of a tooth leads oftentimes to a fistulous opening, which, as a rule, is situated upon some point of the adjacent gum, when it is called *parulis* or gum boil. Rarely the pus finds an exit externally through the skin.

TREATMENT.—The affected tooth should be removed; or if it be desirable to preserve it, the patient should be placed under the care of a surgeon dentist.

Ranula.

This is a tumor situated in the sublingual region. It is of a whitish color, tense, elastic, indistinctly fluctuating, and contains a thick albumen-like substance. It is believed by some to be a mucoid cyst, by others a dilatation of the duct of the sub-maxillary gland. It is generally about the size of a pigeon's egg—painless, but interferes with deglutition and pronunciation.

TREATMENT.—Evacuation of its contents by a partial excision of the wall of the sac, and subsequent injection of tincture of iodine or other stimulating and astringent mixture. Extirpation is rarely practised.

Lipoma.

Lipoma is an hypertrophied condition of the skin with accumulation of adipose tissue of the apex and alæ of the nose. It is almost entirely confined to elderly males, addicted to high living and wine-bibbing.

TREATMENT.—If the growth is of moderate size, change of life, active purgation, and painting the part with tincture of iodine are effective. But if the growth is excessive, its removal by the knife presents the only prospect of relief.

Rodent Ulcer.

Rodent ulcer is an affection of the face, probably cancerous, characterized by ulceration of the eyelid, cheek, or upper lip. The ulcer is of an irregular shape, though tending to oval; its base is apt to be uneven and excavated, but not nodular; its walls are rounded.

TREATMENT.—The parts should be extirpated by the knife or caustic. The disease is liable to recur.

Rhinoplasty.

Rhinoplasty, or that operation by which a new nose is fashioned, is performed in two ways, known as the Italian and Indian methods. In the Italian, the flap of skin from which the new organ is to be modelled is dissected from the arm of the patient, a narrow pedicle alone preserving the connection between it and the common integument. It is then placed over and coadapted to the freshened surface of the nasal region, and retained in position by the arm being elevated, and the hand held to the head by appropriate apparatus, until the parts have thoroughly united. The pedicle is then cut across, and the arm is allowed to resume its natural position.

The Indian method—the one ordinarily practised—consists in removing from the forehead a cordiform flap of integument having its apex upwards and its pedicle downwards towards the nostrils. This, being dissected free, is twisted upon the narrow portion, and accommodated to the site of the new organ. The left side of the flap should be longer than the right, and in order to allow for contraction of the flap it must be liberally proportioned. A flap a third larger than the apparent need, is not in excess. For details of this complicated operation standard works must be consulted.

Salivary Fistula.

Salivary fistula results from a wound or ulcer of Steno's duct, and has been known to follow profuse ptyalism. The saliva, instead of entering the mouth, flows out upon the cheek. The object of treatment is to close the external opening, and permanently connect the duct with the mucous surface. This is best effected by paring the edges of the fistula with the knife, and approximating them by suture, while the orifice of the duct is maintained in a patulous condition by a pledget of lint.

DISEASES AND INJURIES OF THE THROAT.

Tonsillitis.

Inflammation of the tonsils is recognized by swelling, pain, and difficulty in deglutition. It is usually associated with inflammation of the uvula and fauces. It should be combated by purga-

tives, leeches to the neck, application of nitrate of silver to the mucous surface, etc. Should it become necessary to open an abscess of the tonsils, the point of the instrument should be directed inwards to avoid wounding the internal carotid artery. The tonsil may become enlarged as a result of inflammation, but more often independently of it. The latter form is commonly seen in strumous children. The growth interferes with swallowing and breathing, and may occasionally produce deafness by pressure against the Eustachian tube. Attention to the general health may reduce the enlargement, especially if it be in association with disease of the lymphatics. In the event of failure of medication, the tonsil should be excised. This is best accomplished by drawing forward the gland by a tenaculum or forceps and cutting off a portion of the protruding mass. The tonsilotome is for this purpose preferred by some. It is not essential to remove the entire gland.

Cleft Palate.

This is a congenital deformity due to the incomplete approximation of the lateral halves of the palate. It may be confined to a portion of the soft palate, or may extend along the roof of the mouth and involve the alveolar region. Cleft palate interferes with suction, deglutition, and, when marked, with mastication. The speech is guttural and nasal. When the fissure is extensive and indicates much absence of bone, the only treatment advisable is the employment of a silver or vulcanized plate moulded to the contour of the palate and retained in position by the teeth and gums. Such a plate is known as an obturator, and can be best furnished by the dentist. When the slit is smaller, and either confined to the soft palate or found involving the hard palate to a moderate degree, the operation of staphyloraphy may be attempted. This consists in freshening the edges of the fissure and uniting them with suture. In order to render the naturally irritable parts indifferent to handling they should be systematically manipulated for some time before the operation. Division of the levator-palati and palato-pharyngeal muscles prevents retractility of the palate, and facilitates the operation. When the fissure involves the hard palate, the adjacent mucous membrane may be employed in closing it. To this end, the tissues on either side of the cleft are dissected from their bony attachments as far as may be required, which, in many instances, may be quite to the base of the alveolar processes, and the two pendent flaps are then united by suture in the median line.

CHAPTER IX.

SURGICAL AFFECTIONS OF THE NECK AND THROAT.

Stricture of the Œsophagus.

This may be spasmodic or organic. Spasmodic stricture is dependent upon derangement of the nervous system, and is confined for the most part to children and hysterical females. It is best relieved by antispasmodics, and tonics. Organic stricture is the result of inflammation in the mucous and submucous coats, very generally produced by the action of hot water or acrid liquids, and is commonly seen at that portion of the gullet behind the cricoid cartilage.

The prominent symptoms are difficult deglutition, uneasy sensations about the neck, regurgitation of fluids, impossibility of swallowing solid articles of food, etc. Dyspepsia, constipation, and emaciation become, naturally, accompaniments of the disease. Death from exhaustion may ensue.

The TREATMENT should consist of gradual dilatation of the stricture with bougies, while the strength is supported by careful attention to diet. An alterative course of medication followed by tonics is commonly indicated.

Foreign Bodies in the Œsophagus.

These consist of a variety of objects, such as fish-bones, fruit-stones, coins, artificial teeth, etc.

TREATMENT.—Placing the patient in a sitting position in a good light, an attempt should be made to discover the position of the body. If lodged in the upper portion of the tube it may be secured by the finger and at once withdrawn. When beyond such a point the dressing forceps, or, what is better, the curved œsophageal forceps, may be employed to effect extraction. Should it be impracticable to afford relief in this way, an emetic should be given, hoping that in the act of vomiting the body may be ejected. Œsophagotomy is an operation proposed to remove an immovably fixed obstruction. The incision, several inches in length, should be made opposite the foreign body, between the sterno-mastoid muscle and trachea, care being taken to protect the carotid artery, the pneumogastric nerve and its recurrent branch from injury. The œsophagus should be opened to as small an extent as possible, and the foreign body withdrawn with finger or forceps as may be most convenient.

DISEASES AND INJURIES OF THE AIR PASSAGES.

In the successful treatment of these affections an acquaintance with the laryngoscope is necessary. This instrument, as perfected by Czermak in 1857, is designed, by means of a strong light thrown upon the parts, to reflect an image of the glottis and interior of the larynx to the eye of the observer. As modified and in general use, the instrument and accessories comprise a lamp with an argand burner; a condensing lens; a reflector fixed to the forehead of the operator by means of a band encircling the head; and a number of small mirrors of various forms and sizes, mounted upon handles. The patient is seated beside the lamp, which is so arranged that the light is thrown directly forward through the lens, to be reflected from the mirror on the head of the surgeon. The mouth being held widely open, the rays of light thus reflected are thrown upon the glottis, and then, by means of one of the small mirrors, previously warmed, held over the parts, a very satisfactory view of the epiglottis, glottis, interior of larynx, and even the tracheal tube can be obtained.

Œdema of the Larynx.

The parts commonly affected are the lips of the glottis with the epiglottis. The pharynx is always more or less involved. This condition is marked by fits of coughing, difficulty of breathing, and at times impending suffocation, etc.

Treatment.—The use of local depletion and purgatives is generally indicated. Scarification of the parts may be practised where immediate relief is called for. Astringent washes may be employed with benefit; that of a strong solution of nitrate of silver being perhaps the best. Should the danger of suffocation at any time become imminent, the surgeon should not hesitate to perform tracheotomy.

Scalds are more frequent among children, and are occasioned by inhalation of steam, or contact of hot fluids. Death is apt to ensue from spasm of the glottis or inflammation. Purgatives and demulcents with local depletion are indicated. Resort to tracheotomy affords the last chance for relief in desperate cases.

Foreign Bodies.

Small substances, such as cherry-stones, grains of corn, watermelon seeds, pieces of wood, etc., when held in the mouth, are sometimes drawn into the larynx or trachea during a full inspiratory effort, as in sudden laughter. Such an object, when lodged within the rima glottidis, may at once be removed with but little trouble; but when thrown within the trachea serious consequences follow if it be not thrown off or extracted. The accident is invariably followed by severe spasmodic coughing, which continues with little cessation until the irritability of the parts is in a measure obtunded and the patient exhausted. The coughing, however, continues at irregular intervals, and is productive of loss of sleep, great irritability, emaciation, and general malaise. Sometimes the body lodges in one of the bronchial tubes (generally the

right), which is consequently in a measure occluded, and the lung of the corresponding side is rendered impermeable to air.

TREATMENT.—If the foreign body be not ejected by the ensuing convulsive coughing, laryngotomy or tracheotomy should be at once performed, particularly if the object be of a seed-like nature, which, swelling with moisture, becomes in a short time increased in size and more difficult to dislodge.

Laryngotomy.

This is performed by making a longitudinal incision one inch and a half long, in the median line, dividing skin, cervical fascia, and crico-thyroid membrane. The crico-thyroid artery may require division and ligation.

Tracheotomy.

A superficial incision is made from the base of the cricoid cartilage to within an inch of the sternum. The sterno-thyroid and sterno-hyoid muscles are next separated from one another, and the cervical fascia and thyroid plexus of veins beneath are exposed. The veins are to be carefully protected or ligated, and the trachea opened from below upwards to the extent of three rings. If after the removal of the body the larynx be clear, the wound can be closed. But should the larynx be obstructed, by the impacted foreign body, pseudo-membrane, or other substance, the opening must be prevented from healing. For this purpose a silver tube is inserted into the trachea, furnished with a shoulder by which it is retained in position. This serves as a sheath for a second tube, through which breathing is effected, and which is only removed when clogged with mucus or in other ways obstructed.

Wounds of Neck.

Wounds of the neck offer a few peculiarities on account of the important vessels and nerves traversing the region. The most important injuries here sustained are wounds resulting from attempts at suicide by "cutting the throat." These, although resulting in frightful lesions from the extent of tissue involved, not unfrequently prove abortive. The sufferer, from his ignorance of the importance of the structures he divides, oftentimes merely opens the larynx or trachea, without severing any important nerve or artery. Hemorrhage in such cases is often profuse, and is generally seen to arise from the lingual or thyroid arteries.

TREATMENT.—All bleeding points should be ligated. If the pharynx or œsophagus be wounded, food must be administered through a tube inserted by the mouth. The edges of the wound should be united, and protected by a light dressing. After the immediate effects of the wound are over, danger may be anticipated from pulmonary inflammation. Tracheal fistules sometimes persist after all the other parts have permanently healed.

Torticollis or Wry Neck.

This is distortion of the neck to one side, and is due either to contraction of the muscle of the distorted side, or to paralysis of

the opposite muscle; though cases of deformity due to the latter cause are rare. It may also be the result of vicious cicatrices, caries of the spine, etc. It is more common in the female than in the male. When the affection is in its early stage benefit may be expected from attention to the general health, administration of tonics, shampooing, stimulating frictions, and the cold shower-bath. When, however, it is confirmed, the only certain means of relief lie in the division of the sterno-cleido-mastoid muscle near its points of origin. This is effected by the subcutaneous operation of tenotomy. The head should be afterwards supported in Jörg's or some similar apparatus until the parts are accustomed to their new relations.

Bronchocele, or Goitre.

Bronchocele, or goitre, is a chronic enlargement of the thyroid gland. Of an endemic origin, it is, for the most part, confined to valleys in the mountainous regions of the temperate zone, as the Alps or Pyrenees; and in this country (more rarely seen), to the Eastern and Middle States. In Europe, particularly in the Alps, it is often associated with cretinism. The tumor is of gradual growth, and is more common in the female than in the male. It is painless, and only annoys by its presence. Owing to the enormous size which it sometimes attains, this may eventually prove to be a source of discomfort. The cause is obscure, but it is probably due to the humid atmosphere of the valleys, together with neglect of hygienic measures on the part of the inhabitants.

TREATMENT.—The patient, if possible, should be removed from the country. The preparations of iodine are especially indicated. Both internal and external use of the drug may be at the same time recommended. The general health should be carefully guarded, particular attention being given to diet and exercise.

CHAPTER X.

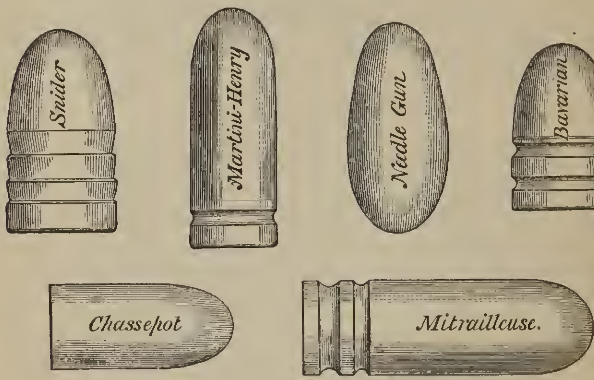
INJURIES AND SURGICAL AFFECTIONS OF THE CHEST AND ABDOMEN.

Wounds of the Chest.

WOUNDS of the chest may be external or internal. The former, unless complicated with fracture of the ribs, require the same treatment as simple wounds elsewhere. The latter are more serious, and may be penetrating or perforating. A penetrating wound pierces the parietes of the chest, and may or may not wound the lung. It is commonly produced by a dirk or bullet; but occasionally follows fracture of the rib from a fall. A perforating wound involves both parietes of the chest with intervening contents. It is almost always the result of a gunshot injury.

In gunshot wounds, of the chest or of any other part of the body, the effects of balls vary with their *character*, *direction*, and *speed*. Modern balls are much more destructive than the old round bullets; lacerating the soft tissues badly, even when "spent." When a rifle-ball strikes the body while it is moving at full speed, the orifice of entrance is round and small; that of exit, large and

Fig. 382.



lacerated. Sloughing of the track of a ball is to be expected; and secondary hemorrhages are frequent and dangerous.

Immediately succeeding an internal injury, shock of the nervous system is conspicuous; dyspnœa, distressing cough, orthopnœa, and emphysema follow. Hemorrhage may occur from the intercostal arteries, or from the lung substance. In the latter case blood flows into the thoracic cavity, whence it is occasionally ejected through the wound during the paroxysms of coughing. When the lung is wounded there may be bloody expectoration. Rarely air enters the cavity of the thorax (pneumothorax) when the dyspnœa is increased. To these symptoms may succeed pleurisy, and to this complication, especially when suppuration is excited, empyema.

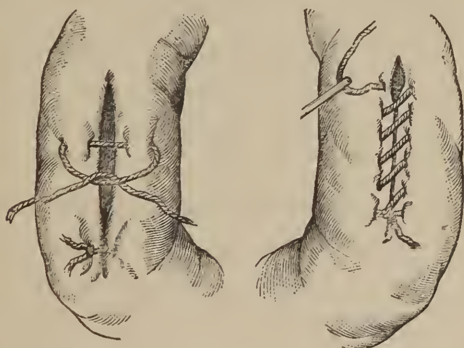
Treatment.—If the source of the hemorrhage be an intercostal artery, it should be tied; when, owing to its retraction, this is difficult to accomplish in the ordinary way, a curved needle armed with a silk ligature will commonly prove effectual. Should it be now ascertained that the lung is uninjured, the wound may be accurately closed. When the bleeding arises from a wound of the lung substance, though free at first, it ceases after a while spontaneously. The external wound in such cases should be covered with a light, compact dressing, but not permanently closed, in order to permit the pent-up blood, serum, and pus lying in the thoracic cavity to find occasional exit. Complications are to be treated severally as they arise. General bleeding, at one time extolled, is now rarely resorted to. Traumatic pleurisy is best

combated by purgatives and antimonials. When the chest is distended by accumulation of fluid (which is commonly pus), the original wound, it may be, having closed, it becomes necessary to tap the chest (paracentesis thoracis). This is best accomplished by piercing the intercostal space between the sixth and seventh ribs, half-way between the spine and the sternum. At a point lower than this the diaphragm might be wounded; at a point higher, the fluid could not readily escape.

Injuries of the Abdomen.

Contusion of the abdomen may be very severe, and yet no external evidence of the injury may be apparent. A heavy vehicle passing over the abdomen, and compression between two railway cars, are examples of the ordinary causation of the accident. The liver is often lacerated; the spleen and kidney less frequently. The hemorrhage within the abdominal cavity is often copious. The skin becomes jaundiced, pallid; pulse flickering. Such cases generally terminate in death within two or three days. Wounds of the abdomen are penetrating or perforating, and may be either incised, lacerated, or punctured. If the viscera be not wounded, and the dangers of peritonitis are escaped, such wounds do well. Wounds of the liver are generally fatal from the subsequent hemorrhage from the patulous orifices of its vessels. Even a small wound of this viscus may be productive of pain and jaundice, while recovery is slow. Wounds of the gall-bladder, spleen, and urinary bladder are generally fatal through the acute peritonitis they induce. Penetrating wounds, where the intestine is uninjured,

Fig. 383.



Application of Sutures to the Intestine.

are treated by approximating the sides of the wound with the interrupted or continued suture, and applying a light dressing. Perfect rest should be enjoined. Peritonitis supervening should be combated by leeches and opium. Where the wound is large, portions of omentum and intestine may protrude; these should be returned, and the wound covered with a compress. If it be imprac-

ticable to replace the bowel without undue violence, the wound should be slightly enlarged; or, if this be deemed unadvisable from the proximity of an important vessel, the inflated bowel may be punctured with a needle or bistoury, and its contents allowed to escape; after which the intestine can be returned. Masses of protruded omentum have been left to strangulate and slough away, with no bad symptoms following. Wounds of the bowel are recognized by diffuse pain in the abdomen, tympanites, nausea, and prostration. Blood occasionally escapes by the anus. When hemorrhage is severe the pulse becomes small and tremulous; the surface is covered with clammy sweat, and there is intense thirst. When the wound is a punctured or a small lacerated one no danger need be apprehended, since it is not probable that any fecal contents will escape. The wound contracts immediately with eversion of the mucous membrane, and in this way may be entirely closed; a result aided by the presence of a moderate amount of inflammatory product agglutinating the lips of the wound to some adjacent coil of intestine. But if, from its size, it be necessary to close the wound, it can be best done by the interrupted suture. To effect this, the tunics of the bowel, except the mucous membrane, are coadapted and the ends of the ligatures cut short. During the process of healing the threads are entirely enveloped. In a few days, varying from three to eight, the threads are pushed through into the bowel and are discharged by the anus.

Artificial Anus.

Artificial anus is a name given to an opening in the parietes of the abdomen communicating with the intestine. When small, it is termed fecal fistula. It may arise either from wounds or the sloughing consequent on strangulated hernia. A spur-like process (eperon) is seen within the opening, which is formed by the flexure of the coil of intestine involved. Below the spur the gut is contracted, since the greater portion of the fecal contents escapes externally. The borders of the opening are everted and reddened, while the surrounding skin is excoriated. The patient frequently suffers from inanition, and is depressed by the foul nature of the discharge.

Treatment consists in supporting the strength, and closing the opening by a compress or truss. The fistula often heals in time, spontaneously; the larger opening, more rarely. To promote a cure it is necessary to remove the spur. To effect this Dupuytren's forceps are used, which being made to grasp the fold securely are allowed to remain in position until it sloughs away, the amount of pressure being regulated by a screw at the handle. Dr. Physick ligated the spur by inserting a curved needle armed with silk thread into the upper gut, and passing it through the fold and bringing it out through the orifice of the lower gut. The extremities of the ligatures were then loosely tied. After the third or fourth day, sufficient inflammation having been set up to effect consolidation, the mass was removed by a bistoury.

CHAPTER XI.

HERNIA.

Hernia, or rupture, is a protrusion of a portion of the abdominal contents covered by the integument. It may occur at any point of the abdominal wall, though most frequent at those naturally weak. Large size of the outlets of the abdomen, and a relaxed condition of its walls, are among the principal predisposing causes, while straining at stool, difficult parturition, lifting heavy weights, playing on wind instruments, etc., are the main exciting causes. Hernia is divided into oblique inguinal, direct inguinal, femoral, umbilical, ventral, diaphragmatic, lumbar, obturator, ischiatic, perineal, labial, and vaginal. A hernia is composed of a sac and its contents. "The sac is the prolongation of that portion of the peritoneum which overlies and corresponds to the aperture through which the hernia protrudes." It is composed of a neck, body, and fundus. A quantity of fluid is always found in it. When the contents of the sac consist of intestine alone it is called *enterocele;* when of omentum alone, *epiplocele;* and when of a mixed character, *entero-epiplocele.* An enterocele is soft, smooth, elastic, globular, clear on percussion, and disappears suddenly under pressure with a gurgling noise. An epiplocele is more irregular in form, doughy, dull on percussion, and is returned without noise. An entero-epiplocele possesses mixed characters.

The conditions of hernia are recognized as three, viz.: reducible, irreducible, and strangulated.

Reducible Hernia.

Reducible hernia is that form in which the contents of the sac can be pushed back into the abdominal cavity. The tumor returns upon straining or coughing, or the assumption of the erect position. The sac is rarely or never replaced.

Treatment consists of reduction and retention. Reduction, or taxis, is accomplished by carefully manipulating the tumor while the patient is in the recumbent position, with the abdomen relaxed—the mass being gently pushed along the canal of exit. Retention is secured by a truss. The essential feature of a good truss is a spring properly shaped, which is calculated to make no pressure except at the desired points. The pad should be made of wood or some other non-absorbing material, and should vary in size with the nature of the protrusion. Thus, in inguinal hernia, it should be ovoidal and convex. The spring should be applied two inches below the crest of the ilium. In young children an India-rubber band and pad, without spring, may be substituted. A radical cure may occur in young subjects by the long-continued

application of the truss; but in adults such a result cannot be expected. Operations for the radical cure of hernia have been at various times attempted. The essential features are, closure of the canal either by direct occlusion of its wall by suture, by the injection of irritating substances into the sac, or by securing to the sides of the canal an invaginated portion of integument. Such operations more often fail than succeed.

Irreducible Hernia.

Where the protruded parts cannot be restored to the abdomen, the hernia is said to be irreducible. This may be owing to adhesions between the sac and its contents, to hypertrophy of the protruded omentum and bowel, or to contraction of the peritoneal cavity. There are flatulence, eructations, and constipation. The bowels should be regulated and the diet made simple. The parts should be supported by a truss having a hollow pad, or when the tumor is bulky by suspending the parts in a gum-elastic bandage.

Strangulation.

Strangulated hernia is a forcible retention of a portion of omentum or bowel within the sac, and is generally caused by a fresh coil of intestine being protruded into the sac, violently compressing its contents. The seat of stricture may be in the fibrous structures without the neck, within the neck, or in the body of the sac itself. There is compression at the neck of the sac, with occlusion of the intestine and its associated bloodvessels. It is commonly the result of an accident occurring to an old reducible hernia, by which inflammation has been set up in the neck of the sac. The sac becomes tender, especially at the neck; coughing no longer transmits to it an impulse. There are nausea, constipation, and vomiting. The matters vomited are at first ingesta, afterwards stercoraceous matter. If relief is not obtained, hiccough and peritonitis ensue; the mind wanders; the face assumes a peculiar expression, known as the hippocratic countenance; mortification of the part sets in; the pain ceases, and death may terminate the case at a period varying from three to five days. Occasionally the integument sloughs over the seat of the mortified intestine, and if the patient survives, an artificial anus is formed.

The SYMPTOMS of strangulated hernia may be imitated by colic, intussusception, and peritonitis. An inflamed irreducible hernia is accompanied by vomiting and pain; but the pain is confined to the body of the tumor, while the constipation is not complete.

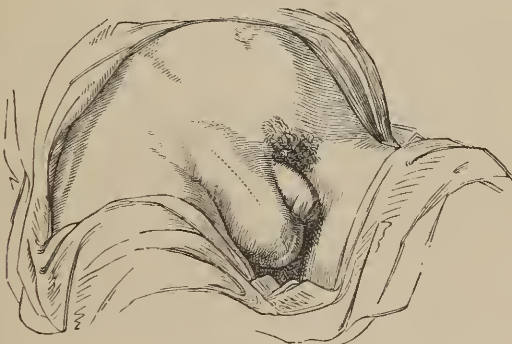
TREATMENT.—Attempts should be made to reduce the hernia by the method known as *taxis*. The patient, previously etherized, should be placed in the recumbent posture with the head elevated and the lower limbs drawn up. The abdominal parietes being thus relaxed, the left hand grasps the abdomen above to fully extend the parts, or is employed to fix the neck of the tumor, while the right exercises firm, continuous, yet gentle pressure upon its body. These measures generally succeed in reducing the mass. The warm bath may, in certain cases, be used as an adjuvant. When neither ether nor choroform is available, tobacco enemata,

venesection, or the prostrating influences of tartar emetic may be employed. Applications of bags of ice to the tumor often prove valuable. Should these efforts be unavailing, an operation should be performed without delay.

Inguinal Hernia.

Inguinal hernia, or bubonocele, is that variety which involves in its protrusion the abdominal rings. It may be indirect or direct.[1] When the hernia appears at the internal abdominal ring, and passes down the inguinal canal, along the course of the spermatic cord in the male, or round ligament in the female, to protrude at the exter-

Fig. 384.



INGUINAL HERNIA.

nal ring, it is called *oblique* or *indirect* inguinal hernia. This is the most frequent form of the injury, and is more often seen in the male than in the female. When it is retained at any portion of the canal it is recognized as incomplete or concealed hernia. The knuckle of intestine as it presents itself at the internal ring pushes before it in its descent all opposing structures, so that they form for it a number of layers or coverings. These, when the hernia is complete, are, from within outwards, peritoneum, transversalis fascia, cremaster muscle, inter-columnar fascia, superficial fascia, and skin. The sac is, as a rule, anterior to the spermatic cord; in rare instances only is it posterior to the deep-seated epigastric artery, lying to the inner side of the neck.

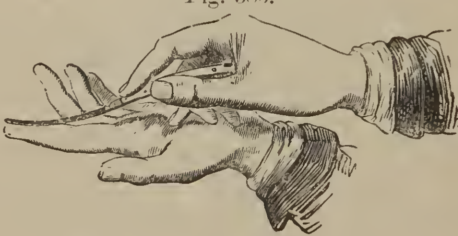
Scrotal hernia is a form of inguinal hernia, the viscera continuing down into the scrotum, receiving an additional covering in the dartos. It, oftentimes, attains great size, and is very generally irreducible. When the protrusion occurs at the external abdominal ring, without having traversed the inguinal canal, it is called *direct inguinal* hernia, and has for its coverings the peritoneum, the conjoined tendon of the tranversalis and internal oblique muscles, superficial fascia, and skin. Sometimes the conjoined tendon is

[1] For the anatomy of hernia the student is referred to ANATOMY.

split, allowing the gut to protrude through the rent. The tumor is near the symphysis pubis, and has the epigastric artery to its outer side.

The operation for strangulated indirect inguinal hernia consists in cutting down upon the sac, and dividing the stricture. This may be done, either by opening the sac, the usual method, or removing the constricting points outside the sac. The seat of constriction sometimes being in the sac makes the latter operation the less certain of success. The patient being brought to the edge of the bed, the bladder having previously been emptied, an incision, varying from two to three inches in length, should be made along the axis of the tumor, dividing the skin. The superficial fascia should next be cut through, and the other coverings overlying the sac, representing from without inwards the intercolumnar fascia, cremaster muscle, and transversalis fascia, are to be successively taken up upon a director and divided. Owing to the thickening, and other inflammatory change, the different layers cannot always be recognized. The presence of the sac is detected by a bluish vesicular appearance of its surface, and by the absence of flexure, such as exists in a coil of intestine, as well as by its peculiar tension. To be certain of its identity a portion should be taken between the thumb and first finger and the two surfaces gently opposed; or a delicate puncture may be made with a needle, when the escape of a serous fluid will at once decide the question. When the sac is opened a quantity of fluid, varying in quantity from an ounce to a pint, escapes, and the intestine is brought into view. The index finger of the left hand, being now inserted into the sac and carried up along the neck, is used as a guide for the introduction of a probe-pointed bistoury or hernia

Fig. 385.



Mode of Dividing the Stricture.

knife. This is borne flatwise until it reaches the neck, when its point is inserted beneath the stricture, and the cutting edge is presented for its division. To effect this the incision should be directed upwards to avoid wounding the epigastric artery, and should never exceed a quarter of an inch in length. The stricture may be situated either at the internal or external ring. The subsequent steps of the operation vary with the condition of the knuckle of intestine. If it be of a light red or deep chocolate color, indicating congestion or slight inflammation, it should be

returned to the abdomen by gentle pressure with the fingers. If, however, mortification is threatened, the mass must be retained in the sac. Should mortification actually take place the dead gut should be removed and the case treated as one of artificial anus. When bowel and omentum are together present in the sac the former should be first replaced, and if the omentum be unyielding it may be removed by the knife after the base has been ligated. Care should be taken in retrenching the omentum to avoid wounding the intestine, a fold of which may possibly be concealed within it. After reduction the wound is closed by a few interrupted sutures, a light compress is applied, and perfect rest is enjoined. The bowels should be kept quiet with opium. After suppuration sets in care should be taken to prevent the flowing of pus backwards into the cavity of the peritoneum.

The operation for direct inguinal hernia is in all essential features the same as that for direct. The cremaster muscle is wanting as a covering, and at times the bowel protrudes through a slit in the conjoined tendon.

Congenital Hernia.

Congenital hernia is the protrusion of a fold of intestine along the imperfectly closed canal for the descent of the testicle from the abdomen to the scrotum. In such a case the tunica vaginalis is continuous with the peritoneum, and forms the proper hernial sac.

Femoral Hernia.

Femoral or crural hernia is the protrusion of gut, or omentum, or both, through the crural canal.[1] The tumor is more globular than the inguinal form, and is, as a rule, smaller, rarely attaining a size greater than that of a horse-chestnut or pigeon's egg. It appears upon the anterior and inner aspect of the thigh, escaping through the saphenous opening, having the femoral vein to its outer side, Poupart's ligament above, epigastric artery above to its outer, and, in the case of the male, the spermatic cord to its inner side. It is much more commonly met with in the female than in the male, and rarely occurs before the age of twenty. The coverings of femoral hernia from within outwards are peritoneum, crural septum, crural sheath, cribriform fascia, superficial fascia, and skin. Fascia propria is a term very commonly applied to the coverings of the hernia intervening between the peritoneum and superficial fascia. Strangulation occurs more frequently in femoral than in inguinal hernia, and gangrene of the constricted knuckle sooner supervenes.

Treatment.—When the rupture is reducible a truss resembling that employed in inguinal hernia, but having a smaller and more convex block, should be applied, though on account of the depth of the canal, complete retention is not to be expected. When the hernia is strangulated, taxis is to be at once performed. The body should be bent forwards, the limbs flexed and adducted so as to thoroughly relax the parts, when pressure should be made, first

[1] For the anatomy of these parts the student is referred to Anatomy.

downwards to disengage the gut from the upper edge of the saphenous opening, and then upwards along the course of the great vessels. Should this fail in procuring relief, an operation should immediately be performed. The parts having been shaved, a single incision along the vertical axis of the tumor should be made its entire length. If the tumor be large, this may be joined by another at an angle to it, made parallel with Poupart's ligament, to the extent of two inches. After dividing the skin and superficial fascia, the fascia propria is discovered. This is commonly thick, and contains a quantity of fat, an incision through which reveals the sac. The stricture being often external to the sac, it may be only necessary at this stage of the operation to divide it and restore the gut by taxis. If, however, after such attempt the tumor be yet unreduced, the sac must be opened and the stricture sought for at its neck. This step requires great care, for the quantity of serum within the sac is small and the sac lies in close proximity with the intestine. A hernia knife, previously somewhat dulled, should incise the stricture, which may be at the superior border of the saphenous opening (Hey's ligament), at the internal border of crural ring (Gimbernat's ligament), or in the neck of the sac itself.

Fig. 386.

Operation for Femoral Hernia.

The incision should never exceed two lines in length, and must be made upwards and inwards to avoid wounding the epigastric artery. The obturator artery, which rarely runs along the inner side of the neck of the sac, is at times in danger of being wounded. After the restoration of the gut the fascia propria may form a small tumor in the position of the rupture. The wound should be closed as in the operation for inguinal hernia. The after-treatment is in all respects the same.

Umbilical Hernia.

This variety occurs in infants and adults. It may be congenital, but more commonly occurs a few months after birth, consequent upon some violent straining effort, as in crying. The adult form occurs in women who have borne many children. Here the rupture is not directly at the navel, but a few lines below it. The coverings of umbilical hernia are, peritoneum, superficial fascia, and skin. Strangulation is a rare accident.

TREATMENT.—The infantile form is effectively treated by a compress and bandage, or a spherical pad with a convex surface is adapted to the parts and secured in position by broad strips of adhesive plaster which should be carried completely round the body. In the adult form the tumor, when irreducible, should be supported by means of a truss furnished with a concave pad. When strangulated, attempts should be made to effect replacement, for which purpose pressure should be made upwards and backwards. An operation is required when taxis fails. An incision should be made in the median line two inches long over the neck and upper portion of the tumor; the stricture is found at the superior edge of the opening. Every means should be resorted to, by division of external confining bands, prior to opening the sac, since peritonitis is likely to follow such a step, with a fatal result. Symptoms of strangulation occurring in old women with irreducible hernia may often be successfully combated by leeches, fomentations, and aperients.

Other Varieties of Hernia.

Ventral hernia is a protrusion of the intestine at any point except the navel and groin. It very generally arises from a traumatic cause. The localities of the *diaphragmatic*, *lumbar*, *obturator*, *ischiatic*, *perineal*, *labial*, *and vaginal hernia*, all of which are rare, are expressed in their names.

CHAPTER XII.

SURGICAL AFFECTIONS OF THE RECTUM AND ANUS.

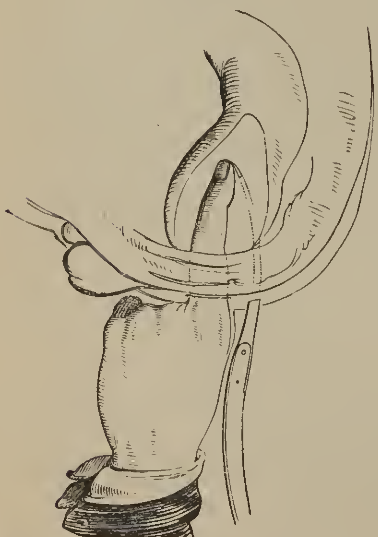
Fistula in Ano.

THIS is the result of abscess in the neighborhood of the rectum. It is incomplete or complete: incomplete internal when it communicates with the skin but not with the gut; incomplete external when it opens into the rectum, but does not involve the skin—such are also termed blind fistulæ. Complete fistula communicates both with bowel and nates. It may be single or multiple, and may join the bowel immediately above the sphincter ani muscle, the usual site, or may include several inches of the rectum in its course.

It is more common in middle age, and among men than among women. There is pain on defecation, with heat in the part, discharge of pus, flatus, etc. In cases of long standing the involved tissues become greatly indurated.

TREATMENT.—The sinus should be at once converted into an open sore by division of the sphincter ani muscle. This is best accomplished where the fistule is of moderate length, by inserting a grooved director through the sinus and afterwards exposing the end of the instrument upon the buttock of the opposite side, thus placing the instrument beneath the muscle, which is then to be thoroughly divided. Or a probe may be inserted through the sinus into the bowel, and the finger, previously well oiled, introduced into the rectum and brought in contact with the instrument. A probe-pointed bistoury is then passed along the sinus using the probe as a guide. The finger and knife are then withdrawn, the knife dividing in its passage all intervening structures. Lint should be placed in the wound to allow it to heal from the bottom. Opiates should be administered to quiet the bowels. At the end of the third or fourth day a laxative may be given. All local sources of irritation must be avoided. When the fistule is very high up in the bowel, and danger from hemorrhage might accrue from the employment of the knife, the sinus may be destroyed by strangulation with a silk ligature. Fistula in ano is often found coexistent with phthisis. In the opinion of many, no operation should then be performed, since it is thought to aggravate the constitutional affection.

Fig. 387.



MODE OF OPERATING IN FISTULA IN ANO.

Fissure of the Anus.

This is an ulceration or cracking of the mucous membrane and skin on the verge of the anus. It is of a narrow shape, velvety to the touch, and, when chronic, possesses thickened walls. It is more common in the female than in the male, and is frequently found associated with nervous conditions, more particularly hysteria. Its exciting cause is constipation. In some the fissure gives no trouble, but with others there is marked local pain which is intensified by the act of defecation.

TREATMENT.—When small, the application of nitrate of silver sometimes gives great relief. Other treatment consists in violent dilatation of the parts, division of the sphincter ani muscle, or free incision through the ulcer to a point beyond its base. The last operation is preferable, and is very generally followed by immediate relief. The general health should not be neglected.

Hemorrhoids.

Hemorrhoids or piles are tumors due to a varicose condition of the rectal veins. They may be entirely composed of such enlarged vessels, or in part made up of thickened cellular tissue in addition to the vascular element. They are of frequent occurrence, and are more common in males than in females, among the middle-aged than the young, with the luxurious than the frugal. They may be occasioned by any causes tending to obstruct the blood in the pelvic veins, such as hepatic congestion, constipation, sedentary habits, pregnancy, etc. Hemorrhoids are of two kinds, internal and external.

Internal piles may involve all the veins at the inferior portion of the rectum; or, as is most common, they may be confined to those immediately above the verge of the anus. The tumor is concealed within the rectum, except during defecation, when it protrudes. It then presents an irregularly lobed subglobular mass, of a deep purplish-red color. Hemorrhage is of frequent occurrence from a pile in this condition, and often proves to be its most serious complication. Bearing down sensations, heat in the part, shooting, lancinating pain in the pelvis and down the thigh, are among the principal symptoms; while emaciation and dyspepsia are frequently associated with them.

TREATMENT.—Constipation must be combated with laxatives, avoiding aloes and rhubarb, from their tendency to induce congestion of the lower part of the alimentary tract. Hepatic complications should be treated as the indications exist. Confection of black pepper often acts happily in reducing the volume and lessening the irritability of the parts. Locally, astringent injections, such as the infusion of oak bark, zinc, alum, etc., may be employed. Cold water, frequently thrown up the bowel, is a most valuable adjunct. An internal pile, however, is seldom cured without an operation. When it has attained any considerable size, all things being equal, the proper proceeding in such a case is to strangulate the tumor by means of silk ligature or wire. Pure nitric acid applied to the protruded mass with a piece of flattened wood, has been by some highly commended. The *galvanic cautery* is preferred by others.

External piles are situated without the verge of the anus, and are made up of varicose veins and dense cellular matrix. At times, owing to the rupture of some of the vessels, coagula form within them, when they cease to be compressible. They occasionally ulcerate and bleed.

TREATMENT.—The tumor should be removed with the scissors or knife. When the mass is indurated, an incision into it to remove the coagulum will often suffice. The hemorrhage is slight, and is readily controlled.

Prolapsus Ani.

This may be partial or complete. It is of frequent occurrence among children and aged persons. The incomplete form, when recent, is of florid color, without tenderness, but when congested may be the seat of more or less pain. The complete form is an invagination of the lower bowel, the mass protruding some inches beyond the anus. In children, straining at stool, the irritation induced by the presence of intestinal worms, diarrhœa, etc., may occasion the disease. In the aged, enlarged prostate, chronic cough, urinary calculus, etc., are among the predisposing causes.

TREATMENT consists in removing the cause and in restoring the bowel after each protrusion. Feces and urine should be voided in the horizontal position. Astringent washes should be employed to give tone to the parts. When complete and irreducible, an operation consisting of removal of a portion of the folds of the protruded mass with a view of permanently lessening its bulk; has been performed, but without very encouraging results.

Rectal Polypus.

This is a rare disease, occurring more frequently with children than with adults. The tumor, generally pedunculated, is situated in the rectum about three inches above the anus. There is uneasiness in the lower part of the pelvis, and straining at stool, with bleeding. The growth should be removed by ligature or torsion.

Imperforate Anus and Rectum.

This is a congenital affection, and may be occasioned by occlusion of the rectum, by a transverse septum of mucous membrane either at the anus or a point higher up, or by entire absence of the structures entering into the construction of the anus; moreover the anus may be perfectly formed, but the rectum may be found to terminate within in a cul-de-sac. In the female the rectum may, in such cases, terminate in the vagina. In the former instance, an opening should be made through the fold, so that the meconium may be allowed to escape. The mucous membrane should then be secured to the sides of the wound to prevent the formation of a fistulous tract. In the latter, a much more serious condition, an attempt may be made to reach the anus by perineal section, or by opening the descending colon in the left lumbar region as it passes beneath the left kidney (lumbar colotomy), thus creating an artificial anus. Such operations are of doubtful propriety. The mortality is fearful, and the patient, under the best of circumstances, is left in a pitiable condition.

Encysted Rectum.

This consists of an enlargement of the mucous sacs situated in the rectum immediately above the verge of the anus. It is productive of uneasiness, itching, sense of weight, etc., when the sacs become distended with hardened feces.

TREATMENT.—Empty the bowel thoroughly with a cold water enema, and, drawing out the partitions between the sacs, excise them freely with scissors.

CHAPTER XIII.

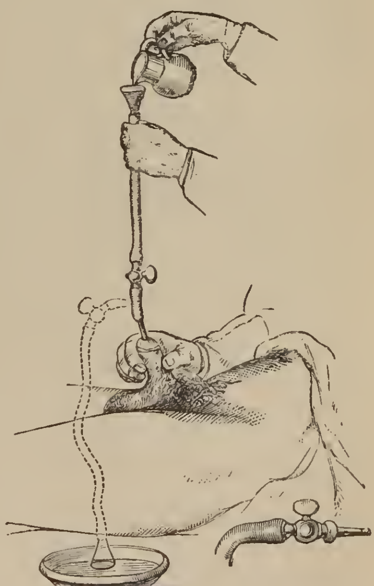
SURGICAL AFFECTIONS OF THE GENITO-URINARY APPARATUS.

Cystitis.

Cystitis (inflammation of the bladder) may be acute or chronic. The acute form is comparatively rare, and generally accrues upon the decline of an attack of gonorrhœa, unskilful use of instruments, etc. There is dull, deep-seated pain in the hypogastric region, with subsequent lancinating pains extending to the perineum, sacrum, and penis. Scalding sensation attends micturition, the urine being voided frequently, but in small quantities at a time. Accompanying the urine there is at first an admixture of mucus, subsequently blood and, it may be, pus. The pulse is full, the countenance anxious, and the tongue coated.

Treatment—*Acute form.*—Leeches should be applied to the region of the bladder, followed by warm anodyne fomentations, or the warm hip-bath. Opiate enemata or suppositories may relieve the pain. Purging should be avoided, though a mild laxative effect, such as that produced by castor oil, is commonly indicated. The chronic form is generally seen in advanced or middle life, and is dependent upon enlarged prostate, stricture, stone in the bladder, paralysis, or obstruction along the ureters or kidneys. It may, however, be uncomplicated. There is great irritability, with incontinence, and voidance of large quantities of mucus and pus of an alkaline reaction and very commonly of an ammoniacal odor. The walls of the bladder become thickened, the muscular coat hypertrophied. The sides of the organ may become sacculated, and lined with a sediment of phosphate of calcium.

Fig. 388.



TREATMENT—*Chronic form.*—The cause, if possible, should be removed; thus vesical calculus may be extracted, stricture dilated, etc. Diseases of the kidneys or ureters should be palliated. After the inflammatory symptoms have subsided under appropriate treatment, one of a class of remedies, of which balsam of copaiba, buchu, pareira, and uva ursi are examples, should be employed, while tincture of the chloride or iron in addition may be administered. Terebinthinate preparations are sometimes beneficial. The bladder should be washed out frequently with tepid water by means of a syringe and a double catheter; or, still better, by pouring water into a piece of India-rubber tube attached to the end of a catheter after its insertion. The injected fluid may be at times medicated with nitrate of silver, alum, etc. (See Fig. 388.)

Rupture of Bladder.

This occurs when the organ is struck while fully distended with urine, or, very rarely, from distension from organic stricture. In the former case a comparatively slight blow, such as a kick over the hypogastric region, a fall from a bed, etc., may produce the lesion. If the laceration occur at a point covered by peritoneum, the urine escapes into the abdominal cavity, when violent peritonitis sets in, very generally terminating in death on the third or fourth day. But if the urine infiltrates into parts without the peritoneal cavity, symptoms of urinary extravasation supervene, under which the patient finally succumbs. In the former case the inflammation must be combated by leeches, opiates, and fomentations—in the latter, punctures must be made into the infiltrated parts to allow the urine to escape, and warm poultices then applied.

Gonorrhœa.

Gonorrhœa is an inflammation of a mucous surface, the result of impure sexual intercourse. It attacks the urethra or vagina, and is accompanied by a muco-purulent discharge. After exposure to the exciting cause the symptoms of gonorrhœa, as observed in the male, appear from the second to the fifth day. At first "an uneasy or ticklish sensation is experienced at the mouth of the canal, which on examination is found more florid than natural, and moistened with a small quantity of colorless or viscid fluid," which has a tendency to glue the lips of the now tumid and reddened meatus together. This stage, which ordinarily lasts from two to four days, merges into the secondary or inflammatory. The symptoms now increase in intensity. The glans is congested, and the entire organ is swollen. If the prepuce covers the glans, partial phimosis is present; if uncovered, there is a tendency to paraphimosis. The discharge is more copious, of a yellowish with sometimes a greenish tinge, and is of a creamy consistence. There is smarting during micturition, the stream of urine being commonly deflected, and it may be twisted or forked. Nocturnal erections are common. This latter condition, generally known as *chordee*, is caused by the inflammatory product existing around the urethra, "gluing the tissues together and rendering this portion of the penis less extensible than the remaining portion composed of the

corpora cavernosa. Hence, in a state of erection, the corpus spongiosum surrounding the urethra, not being able to yield to the distension, acts like the string of a bow, and chordee is produced." The pain thus excited is often severe. More or less constitutional sympathy coexists with the inflammatory stage, particularly if severe physical exercise have accompanied its inception. Buboes may occur, but are unfrequently met with. Orchitis is more often recognized as a complication.

The disease originally attacks the mucous membrane at the anterior portion of the urethra, more especially the navicular fossa, extending backwards to involve, it may be, the entire tract.

Treatment.—In the *first* stage the injection of dilute solutions of acetate of zinc, or sulphate of copper, from one-third to a grain in the ounce of water, may be employed three times a day. "In using the syringe the patient should raise the penis between the forefinger and thumb of his left hand, holding it near the point. He should then carefully introduce the nozzle of a glass syringe into the urethra for the space of an inch or so, and fix it in that position by compressing it gently with his left forefinger and thumb. He then slowly pushes down the piston with his right hand. The injection should be allowed to remain in the urethra for a few minutes. As soon as the syringe is taken away and the left hand removed, the elasticity of the urethra will expel the fluid that has been thrown in."

During the *second* stage the treatment should be that for acute inflammation elsewhere. A brisk purge may be first administered, followed, if fever is present, by a febrifuge and arterial depressant, such as antimony. If the local pain be severe, leeches may be applied to the perineum. No injection other than an opiated glycerin mixture, or tepid flaxseed-tea, is permissible. If there be tendency to nocturnal erection, a full dose of Dover's powder, or a pill of camphor and opium—in the proportion of three grains of the former to one of the latter—may be administered at bedtime, either by the mouth or rectum. The scalding of the urine is best combated by use of large quantities of flaxseed-tea, together with salts of potassium, such as the bicarbonate and acetate. Steeping the penis occasionally in a cup of hot water reduces the local pain, and renders the use of injections less painful. It is usually recommended to so steep the organ both before and after each injection. Perfect rest in the recumbent position should be enjoined. But in those numerous instances where such advice for private reasons is disregarded, it is well to support the genitals by a suspensory bandage. The diet must be simple and unstimulating. Meat, malt liquors, asparagus, and all acids, must be avoided.

Towards the decline of the inflammatory condition, the injections may be employed in the proportions already indicated. In this stage of the complaint the internal use of cubebs and copaiba exercises a marked influence over the disease. The former may be given mixed in sweetened water, in the proportion of one or two drachms of the powder to half a glassful of the liquid. The dose should be repeated three or four times a day. The dose of copaiba is from twenty minims to a drachm three times a day. Its disagreeable taste renders it advisable to administer it in the form of

capsules of gelatin. When taken in mixture, it may with advantage be combined with cubebs, syrup of gum arabic, and hyoscyamus.

Gleet is a slight and chronic discharge from the male urethra, unattended with symptoms of acute inflammation. A few drops of a thin watery fluid escape in the course of the day, and are more frequently noticeable in the morning on rising. The posterior and curved portion of the urethra is the most frequent seat of gleet. The general health is almost always impaired.

Treatment.—A tonic treatment is generally indicated. The tincture of the chloride of iron may be given, with tincture of cantharides in the dose of about three to five drops three times a day. The latter remedy exerts a decidedly curative action in many cases. The diet should be plain and nutritious. Salt meats, cheese, and highly-seasoned articles of all kinds, are to be interdicted. Bathing and passive exercise are beneficial.

With respect to injections, the same rules for their use must be followed as in the case of gonorrhœa. A long-necked syringe is essential to bring the fluid in contact with the membranous portion of the canal. Oftentimes cases which have resisted the above treatment have rapidly improved under the passage of a full-sized catheter or bougie every second or third day. It has been recommended to employ medicated bougies. The use of mercurial ointment combined with extract of belladonna, smeared over the instrument just before its introduction, has met with favor. In those cases needing slight stimulation of the mucous membrane, the diluted ointment of the red oxide of mercury, or an ointment containing a few grains of nitrate of silver may, for a short time, be employed with advantage.

Stricture of the Urethra.

Stricture may be spasmodic or permanent. *Spasmodic stricture* is caused by action of the muscles of the perineum compressing the urethra. It is generally associated with permanent stricture, gleet, or piles. It may, however, be a symptom of hysteria in females. It is brought on by exposure to cold, indulgence at the table, absorption of cantharides, etc. Symptoms of stricture occasionally occur during the treatment of gonorrhœa, from injudicious use of injections, or indulgence in stimulating drinks.

Treatment.—The patient should be placed in a warm bath, warm anodyne stupes should be applied to the perineum; opiate and antispasmodic suppositories are also indicated. Bleeding may at times be necessary; cold water may be poured on the genitals. If these should fail, chloroform must be administered, and a large sized catheter introduced.

Permanent stricture is due to contraction consequent upon inflammation in the mucous or submucous connective tissue — to the cicatrization of an ulcer—or, in rare cases, to a false membrane lining the urethra. An annular stricture results when fibrous bands surround the urethra like a ring; a "bridle" stricture is one where a loop of adventitious structure is thrown across the calibre of the canal. The most common site of the disease is at the junction of the membranous with the spongy portion. At

times the stricture is placed within a short distance of the meatus. It is rare for more than one point to be affected; though as many as seven distinct strictures have been met with in the same individual. Gonorrhœa, calculus, blows, excessive drinking, riding on horseback, are among its principal causes. From the nature of the exciting causes the disease is more frequent among adults than adolescents, and is especially frequent with the middle aged.

SYMPTOMS.—The desire to urinate is frequent, though small quantities are passed at a time, and commonly with pain. The stream is diminished, twisted, forked, and, perhaps, dribbles away in drops some time after the effort of micturition is over. In bad cases the attempt is accompanied with much straining, pain in the perineum and lower extremities, distressing priapism; and may even be followed by rigors. There is often in the beginning a gleety discharge from the urethra, with other evidences of local irritation. Erections of the penis are frequent; the sexual act is painful, and impotence may follow from the inability of the semen to escape. Hæmaturia is occasionally met with, and generally follows the use of intruments. In old cases, owing to the more or less constant retention, the bladder becomes hypertrophied, and the ureters dilated. The constitutional effects are seen in indigestion, and, at times, in impairment of vision.

TREATMENT consists, 1st, in endeavoring to remove the constricting tissue, as by dilatation. A variety of instruments are employed for this purpose, such as catheters, sounds, either metallic or flexible, and bougies of wax or gutta-percha. A catheter of large size should be used in exploring a stricture, and after its seat and extent have been ascertained, a catheter or bougie of proper calibre should be cautiously inserted and an effort made to distend the narrowed portion of the tube. The following general rules for passing a catheter should be obeyed: The patient lies in a recumbent posture, his feet a little higher than his head, the knees drawn up and slightly separated. The surgeon stands to his left side. The instrument, having been warmed and well oiled, is held lightly between the finger and thumb of the right hand, while the penis is raised with the left. The catheter is now introduced between the lips of the urethra; the instrument being held paralled with the line of the groin. It is then passed slowly along, keeping to the lower surface of the canal until past the anterior portion, to avoid engaging in the lacuna magna, when, reaching the bulbous portion, the catheter is brought round to the middle line of the body, bent forwards and downwards. The penis now being slightly stretched to obliterate any existing folds at the membranous portion of the urethra, the point of the instrument enters the bladder. Introduction of the finger into the rectum will aid in directing the point of the instrument. No force, whatever, should be used. The instrument may be introduced by another method. The patient is placed in the erect position, and the instrument, being held vertically, with its convexity toward the operator, is introduced as before. When the bulb is reached the instrument is swept round half a circle until within the middle line of the body; and then, as before, carried downwards and forwards. The instrument should be passed every third or fifth day, employ-

ing, as the parts dilate, increasing calibres. By continuous dilatation is meant the retention of a catheter within the stricture for a period varying from twenty-four to forty-eight hours, during which time a purulent discharge appears with removal of the stricture. Though more speedy, it is less effectual than the method of gradual dilatation.

Rapid dilatation consists in using dilating instruments of increasing sizes at intervals of several hours.

2d. By caustics: those recommended are nitrate of silver and caustic potassa. A small quantity of the selected agent is securely fixed upon the end of a bougie and pressed against the stricture for two or three minutes and withdrawn. The application destroys irritability, softens the stricture, and aids in subsequent attempts at dilatation.

3d. Internal division. This is accomplished by the urethrotome, which being passed beyond the stricture, a cutting edge is exposed which divides the parts upon being withdrawn.

4th. Perineal section. This is adapted to cases where the stricture has resisted milder forms of treatment. It is performed by placing the patient in the position for lithotomy; when, passing a staff down to the point of stricture, an incision is made along the raphe of the penis an inch and a half or two inches in length, opening the urethra directly in front of the stricture and extending the cut backwards. A small director or staff must then be passed through the constricted region, and the indurated tissue subsequently divided. A catheter should then be introduced into the bladder, an opiate suppository administered, and the patient removed to bed. Perineal section fails if persevering dilatation with instruments does not immediately follow the operation.

Urinary Fistula.

Urinary fistula results from the formation of an abscess in the perineum, or from a wound. It is very commonly the sequence of stricture or urinary abscess. The urine dribbles through the opening during micturition.

TREATMENT.—The urethra must be dilated, and the fistula closed by stimulating lotions, caustic applications, or laying open the sinuses, permitting the wound to heal from the bottom. A plastic operation is sometimes made necessary.

Prostatitis.

This presents itself in two forms, the acute and chronic. The *acute* variety is most frequently caused by gonorrhœa, though also arising from abuse of instruments, stricture, excessive venery, etc. There is dull pain in the perineum, a sense of weight and fulness in and about the rectum, scalding pain on micturition, and difficulty in defecation, the stool being commonly flattened. The finger introduced into the rectum discovers the prostate enlarged and exceedingly painful to the touch. An abscess may form between the rectum and bladder.

TREATMENT.—Blood should be abstracted locally by leeches; a hot bath administered, or hot fomentations applied to perineum.

Brisk purgation and the antimonial impression are sometimes required. The diet should be simple; pain is to be allayed by opiates. Should suppuration occur the abscess is to be opened by puncture through the rectum.

The *chronic* variety is most frequent among young men addicted to masturbation, or whose sexual powers have been abused by excessive indulgence. There is a slight discharge of mucoid matter from urethra, with dragging pain in perineum. Digestion is imperfectly performed, and the bowels are constipated. The mind suffers from hypochondria. The discharge is to be distinguished from spermatorrhœa by the absence of spermatozoids, and by the diurnal emission.

Treatment.—The patient's habits must be corrected. He must live simply, avoiding all forms of excitement. The bowels should be regulated. To allay the local irritation anodyne enemata are employed, with the occasional use of the cold hip-bath. In resistant cases cauterization of the prostatic portion of the urethra may be used with benefit.

Hypertrophy of the Prostate.

This affection, due to enlargement of a portion or the whole of the prostate gland, is comparatively common among men advanced in life. If one lobe is alone affected the urethra will be twisted; when the central portion, it will be compressed. There is irritation at the neck of the bladder, desire for frequent micturition—an operation tedious and painful, the patient often assuming the position of kneeling or stooping to effect it. The bladder being imperfectly emptied of its contents, the retained urine becomes alkaline and very offensive. When voided it is found mixed with mucus, and occasionally streaked with blood. By rectal examination the gland is found enlarged.

Treatment is palliative. A catheter, one with a long shaft and large curve being preferred, should be passed from time to time to remove the residuum of urine. In the event of complete retention it may become necessary to puncture the bladder through the rectum. In other respects the treatment should be that for chronic cystitis.

Calculus.

By urinary calculus is meant the deposition of the solid ingredients of the urine along any portion of the urinary apparatus. When the deposit is without form it is known as *sediment*—when crystalline, as *gravel*—when assuming and retaining a definite size, as *stone*, or *calculus*. Calculi are principally of three kinds, and correspond to three constitutional conditions, recognized for convenience as the uric acid, oxalic acid, and phosphatic diatheses, named in accordance with the predominant constituent seen in the concretion in each case. Thus, in the *uric acid diathesis*, the stone is composed of uric acid, or its compounds, with sodium or ammonium. It is of moderate size, smooth, of a brownish color, and upon transverse section is seen to be composed of well-defined concentric laminæ. It is often met with among the gouty and rheumatic, and in strumous children. It is occasioned by indigestion, consequent upon excess at the table; and in children is frequently

brought on by the injudicious use of meats. The urine is scanty, high colored, of an acid reaction; a pinkish sediment settling at the bottom of the vessel, known as the lateritious deposit or "gravel." A "fit of the gravel" is caused by the presence of the crystalline deposit within the kidneys or bladder. It is characterized by pain along the course of the ureters and in the bladder, and is accompanied by febrile symptoms.

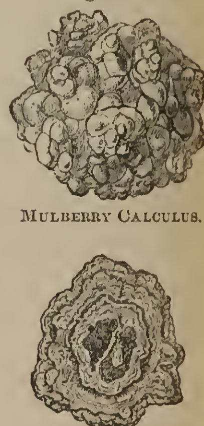
The TREATMENT consists in removal of the cause. The diet should be simple and unstimulating, the habits regular; out-door exercise and cold bathing should be enjoined.

In the *phosphatic diathesis* the calculus is friable, of a chalky appearance, rounded shape, and sometimes attains a considerable size. It may be composed of phosphate of calcium, triple phosphate, or a mixture of these two. The latter is the more common form, and from its action under the blowpipe is called the *fusible calculus.* It is apt to occur among the aged and debilitated, particularly those suffering from nervous exhaustion. Injuries to the spine, and disease of the prostate gland and bladder, are among its predisposing causes. Tonics, generous diet, acids, etc., are indicated.

Fig. 389.

URIC ACID CALCULUS, WITH NUCLEUS OF OXALATE OF CALCIUM.

Fig. 390.



MULBERRY CALCULUS.

ITS SECTION.

In the *oxalate diathesis* the concretion is of an irregular, rounded shape, of a more or less nodular appearance, of a blackish color, and of great relative density. The urine lets fall a slight cloudy deposit, which is made up in great part of crystals of oxalate of calcium. It is met with in exhausted conditions of the nervous system, and is often associated with mental depression, indigestion, masturbation, etc. Mineral acids, such as the nitro-muriatic, are indicated. The diet should be simple, and all saccharine food, or articles containing oxalic acid, such as pie rhubarb, should be avoided.

Renal Calculus.

A stone may form in the kidneys, where it gives rise to pain in the loins, nephritis, and it may be to suppuration and atrophy of the organ. It sometimes descends to pass along the course of the ureter. If the stone be of small size, this is accomplished without pain; but if it be sufficiently large to impinge upon the sides of the tract, excruciating agony is often endured until the calculus escapes into the bladder. There is retraction of the testicle, shooting pain along the spermatic cord and down the thigh of the affected side, with vomiting.

TREATMENT.—During the passage full doses of opium should be administered, and blood abstracted locally, while hot baths and fomentations are resorted to. An anæsthetic should be at once administered if the pain be very severe.

After the calculus enters the bladder it may soon be voided in a flow of urine, or, if of too large a size for this, be retained in that viscus. In the latter case, it serves as a nucleus for further deposit. Foreign bodies introduced into the bladder from without either by accident or design, such as straws, needles, bullets, etc., also afford centres for subsequent accumulation.

The SYMPTOMS of stone in the bladder are, painful and frequent micturition, occasional interruption to the flow of urine, a sense of stuffing and weight in perineum, and irritation and smarting at the glans penis. The prepuce becomes enlarged. There is at times discharge of pus, mucus, or even blood from the urethra. The rectum not unusually sympathizes; hemorrhoids and prolapsus ani are common, more especially in children. Quick movements, as riding or leaping, aggravate these symptoms, when the patient is said to suffer from a "fit of stone." Calculi vary in number from one to several hundred. They generally lie loose in the bladder, but may become encysted.

The formation of stone is influenced by age, climate, and sex. It is more common in males than in females. The states of Kentucky, Virginia, Tennessee, and Ohio, report more cases of renal calculi than any others in this country. The New England States, on the other hand, are remarkably exempt from the disease. Some have supposed that the use of lime-water may favor the formation of calculi. Sex also has its influence, From the shape of the bladder in the female there is less liability for a calculus to be retained than in the male.

The best means of determining the presence of a stone is through the operation of sounding. This is performed by introducing the sound: this is a steel instrument, with a narrow shaft, resembling a catheter in size, but having its curvature much nearer the outer end, a slightly bulbous extremity, and a broad flattened handle. The rectum having been previously emptied, and from three to five ounces of urine retained in the bladder, the instrument should be introduced as in catheterization; the patient lying down with the lower extremities flexed and abducted. The administration of an anæsthetic may be necessary in sounding children. The sound having entered the bladder, systematic examination should be made. The stone, when free, is generally easily reached, but

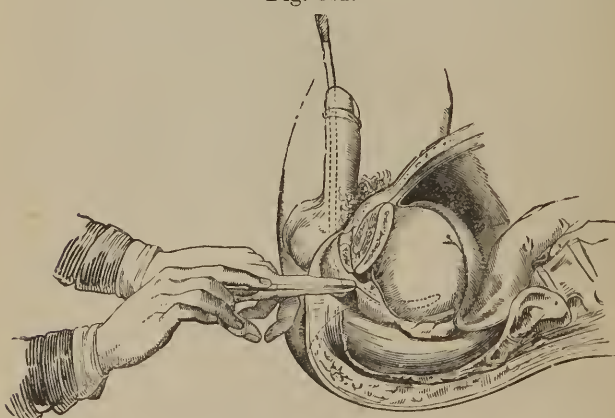
when it is lodged behind the bas-fond, the instrument may pass over it without detecting its presence. The difficulty of arriving at a diagnosis is increased when the calculus is encysted. At the time the sound taps the stone a distinct metallic click is heard, which may be increased in volume by the use of the sounding-board. In some cases, where the presence of a stone is strongly suspected, and yet none is discovered on examination, a second or third operation should be performed, the stone at such times not unfrequently revealing itself when detection before was impossible. The stone may be measured, and its size estimated, by means of the lithotrite, an instrument resembling in its plan the ordinary foot-rule of the shoemaker.

TREATMENT.—Attempts have from time to time been made to dissolve the stone by means of chemical agents, but mostly with but partial success. The only certain means of relief are secured by cutting into the bladder and removing the stone entire (*lithotomy*), or the introduction of an instrument by the urethra, and crushing the stone (*lithotrity*), allowing the fragments to be discharged with the urine.

Lithotomy.

This operation may be performed in a variety of ways. The bladder is commonly entered from the perineum, the methods being known as the median, lateral, and bilateral. The high operation consists in opening the bladder above the pubis. The *lateral operation* is the one generally performed, and will now be briefly described :—

Fig. 391.



OPERATION FOR LITHOTOMY.

The patient is to be prepared for the operation by enjoining perfect rest for a week or ten days previous to the appointed time. The diet should be simple. The day before the operation the

bowels are to be moved by an aperient, and on the morning of the operation the rectum should be emptied by an enema.

The patient should hold his urine for a few hours—or a few ounces of tepid water may, instead, be thrown into the bladder. He is now placed upon a table of convenient height, which is previously covered with a few blankets, his nates slightly projecting from the edge, and so supported as to be on a level with the breast of the operator. The legs are flexed on the thighs, these again on the pelvis, and the extremities strongly abducted ; the hands and feet being either firmly bandaged together, or, as is frequently done, intrusted to assistants to be maintained in the position indicated. The perineum having been shaved, and an anæsthetic administered, the surgeon takes his place directly in front of the patient, and introduces into the bladder a sound to reassure himself of the presence of the stone. This having been done, the instrument is withdrawn, and a staff grooved on the left side is passed into the bladder, hooked firmly under the pubis, and given to an assistant to hold. The scrotum is intrusted to the same assistant, who carries it well away from the line of incision. The external incision is made by entering the knife in the raphe of the perineum an inch and a half in front of the anus and extending it downwards and outwards to the extent of three inches towards a point midway between the tuber ischii and anus. Circumstances may compel the length of the incision to be slightly increased ; in children it may be made proportionately smaller. By this incision the skin, superficial fascia, and subcutaneous fat are divided. The finger of the left hand being introduced into the wound to protect the rectum from injury, the transverse muscle, transversalis perinei artery, a portion of the triangular ligament, and a few fibres of the elevator of the anus, are now divided. The groove in the staff is next sought for, covered by the membranous portion of the urethra, and the point of the scalpel is inserted into it and run forward into the bladder, dividing the neck of that organ and the left lobe of the prostate gland. When the gorget is employed instead of the scalpel, the beak of the instrument is placed in the groove of the staff, guided by the point of the index finger. Immediately following the gush of urine that takes place upon entering the bladder, the finger is inserted into the opening, and by a gentle motion is pushed forwards into the viscus. The staff is now withdrawn, the surgeon still retaining his finger in the wound. The forceps are then passed into the bladder to seize the stone, which is generally found lying at the base of the organ in proximity with the finger. It is best secured by its short diameter, and gently removed. When the stone is small the scoop is used in preference. If it be necessary to employ force in order to extract the calculus, it must be exerted gradually, the evulsion being aided by a rotary motion of the instrument. Should the stone prove unusually large, the opening in the prostate may be backwards enlarged, taking care not to extend the incision far enough to involve the contingent venous plexus. After the removal of the foreign body the bladder is washed out with tepid water thrown in from a large syringe. Any bleeding artery should be at once ligated. Oozing from severed veins may be best controlled

by plugging the wound. For this purpose a canula, surrounded by charpie, sponge, or cotton, is introduced into the bladder, to be retained for several days. Under ordinary circumstances the bleeding is slight, and ceases by the time the calculus is removed.

The patient is now removed to his bed, which has been arranged beforehand by placing upon the mattress a large square of India-rubber or oil cloth, over which is placed a sheet folded several times upon itself. This is designed to receive the discharges, and is to be removed as often as cleanliness demands. A full dose of opium should be administered, and a warm flannel laid across the abdomen. The patient is commonly placed upon his right side. A female catheter may be introduced into the bladder through the wound, to conduct off the urine. For the first three or four hours little or none escapes. After this, owing to the turgescence of the parts about the wound, the urine is voided by the urethra. In the course of two or three days it again passes by the wound, and continues to do so during the process of repair. Antiphlogistic measures are sometimes indicated, though it occasionally happens, as with the advanced in life, that supporting treatment is well borne. Recovery is generally effected in about three weeks.

The *median* operation consists in employing a staff with a groove on its convexity, and making the incision through the raphe of the perineum.

Lithotomy in children presents some peculiarities; in the height of the more vertical bladder, which necessitates a deeper incision than in the adult, and in the liabilty of the viscus to be pushed before the finger in the attempt to enter the wound in the prostate gland.

The dangers attending lithotomy are numerous. The rectum may be opened by the knife in making the deep incision. The pelvic fascia may be wounded, leading to urinary infiltration. Pyæmia may be developed; a fatal complication generally seen among those previously debilitated, or in whom the operation of extraction has been prolonged, or attended by much loss of blood.

Lithotrity.

This is the operation for crushing the stone. The Heurteloup lithotrite (the one in common use) (Fig. 392) is shaped somewhat

Fig. 392.

HEURTELOUP'S INSTRUMENT.

like and is about the size of an ordinary catheter. It consists of two blades, which slide upon one another, and are accurately fitted together. It has a handle, and a long straight shaft. The inner blade moves upon the outer; both are serrated near their

extremities, and when the stone is grasped the force is applied by means of a screw at the handle.

The patient, having been prepared by due attention to his general health, must be placed upon the table with the hips elevated, and about six ounces of tepid water injected into his bladder. An instrument of proper size should then be cautiously introduced and the stone sought for. When it is secured, the operator withdraws the inner blade sufficiently to include the calculus, and being assured that no mucous membrane is involved, the force is applied by gradually turning the screw. The operation may be repeated upon the larger fragments. After the instrument is withdrawn the patient should void his urine. The fragments of the stone, however, should be permitted to remain for three or four days, to allow the sharpness of their angles to be removed; they are then voided from the bladder, the act being facilitated by repeated injections of tepid water. If any difficulty be encountered in reducing the fragments, or if more than a single calculus require crushing, it is best to allow an interval of a week to intervene between the operations. Under the most favorable circumstances, the instrument should not remain in the bladder for more than five minutes at a time, to avoid undue irritation. The after-treatment consists of diluent drinks, and light diet. If pain is present, an opiate enema may be administered.

Lithotrity is most successful when employed upon a soft, single calculus of small size. The genito-urinary organs should be healthy. Among the principal accidents following the operation, are to be mentioned renal irritation, cystitis, orchitis, and pyæmia.

Phimosis.

Phimosis is an abnormal constriction with elongation of the prepuce. There are two kinds—congenital and acquired—the latter being generally the result of cicatrization of ulcers or chancres. The disease is productive of much irritation where the preputial secretions are retained.

The TREATMENT consists in removing the foreskin. This, the operation of circumcision, is performed by drawing forward the parts by a tenaculum or forceps, and with a bistoury cutting off transversely the redundant mass in advance of the glans. Or a bistoury may be introduced upon a grooved director, between the glans and the prepuce, and the integument incised as far back as the corona from within outward. The mucous membrane is then to be stitched to the skin, and the cold water dressing applied.

Paraphimosis.

This—the reverse of phimosis—is that condition in which the glans is exposed, and constricted at neck by the retracted prepuce. It is always of accidental occurrence. The skin becomes œdematous, and the glans congested.

TREATMENT.—To restore the prepuce to its normal relation, an attempt to relieve the congestion should be made by pouring cold water upon the organ for some time. The parts having in this way become less turgid, the hands of the operator are oiled, and

traction is to be made upon the constricted integument with the fingers of both hands, at the same time that the glans is pushed backwards by the thumbs.

Hypospadias and Epispadias.

These lesions result from arrest of union in the mesial line either on the under or upper surface of the penis. When the former, it is termed hypospadias; when the latter, epispadias. Of these, hypospadias is of more frequent occurrence. When of moderate size, an attempt may be made to cure the deformity by means of a plastic operation. Epispadias, being commonly complicated with extroversion of the bladder, is incurable.

Orchitis.

The testis is liable to acute and chronic inflammation. The *acute* form is seated principally in the epididymis. Although it may result from an injury, it is more often a sequence of gonorrhœa, the inflammation being transmitted from the urethra. It may also be caused by direct violence or cold, or may occur by *metastasis* from mumps. There is local pain, swelling—this being chiefly confined to the epididymis—effusion in the tunica vaginalis, and brawny appearance of the skin. There is a peculiar dragging sensation in the cord, with aching pains in the loin and perineum. Fever and vomiting are often accompaniments.

The TREATMENT is antiphlogistic. The tenseness of the parts may be relieved by punctures with the lancet, or through local depletion by leeches, while an active purgative is administered. The exhibition of antimony and opium is often indicated. Perfect rest is to be enjoined. Cold or warm water dressings are to be directed according to the patient's feelings. The weight of the tumor must be sustained by a suspensory bandage. After the subsidence of the acute symptoms, frequent frictions of the scrotum with a mildly stimulating liniment, and subsequent repeated strappings with adhesive plaster, will be found of the greatest benefit.

Instead of adhesive plaster, sometimes a closly fitting gum elastic bag is used.

The *chronic* form may follow an acute attack, or may arise spontaneously. The testicle slowly becomes indurated and swollen. The enlargement, generally confined to one side, may, however, exist on both.

TREATMENT consists in administration of mercury or iodide of potassium; rest, moderate purgation, and application of mild alterative unguents.

Hydrocele.

Hydrocele is a collection of serous fluid in the tunica vaginalis. Sometimes arising without apparent cause, it can most frequently be traced to an injury, a strain, or an attack of orchitis. The vaginal tunic is commonly unaltered. The quantity of fluid varies; an average quantity is about ten ounces. The swelling increases from below upwards. It is smooth, elastic, and fluctuating; translucent under transmitted light, and of an ovoidal or a pyriform figure.

It is free from pain or tenderness, but a feeling of weight and dragging is commonly complained of. The testicle is placed at the upper part of the lower third of the swelling, and at the posterior part of the scrotum. Very rarely is it in association with the forepart of the tunica vaginalis. The tumor does not disappear upon change of position, and there is no impulse upon coughing.

Treatment.—This is either palliative or radical. The former consists in evacuating the serum from time to time; the latter includes several methods of exciting a degree of inflammation in the sac sufficient to prevent further accumulation of fluid. Three plans are recognized—incision, seton, and injection. The last mentioned treatment is the one generally adopted, and is performed as follows:—

The patient being seated, or placed in the recumbent position, the tumor is firmly grasped from behind by the left hand of the surgeon, when a trocar (with canula) is thrust obliquely from below upwards into the tumor at the middle of its anterior part. The trocar is then withdrawn, and the fluid allowed to flow out. A stimulating liquid is now thrown through the canula by means of a syringe into the sac until it is slightly distended. The injection, which generally consists of port wine or equal parts of tincture of iodine and water, is allowed to remain for two or three minutes, when the fluid is pressed out and the canula withdrawn. The preparation recommended by Mr. Curling is composed of iodine ℈ij, potass. iodid. ʒss, alcohol f℥j. Inject two or three drachms, retaining for about five minutes. The pure tincture is often employed in this country. The subsequent inflammation subsides in six or seven days; cure is generally accomplished in three weeks.

Congenital hydrocele is a communication between the peritoneal cavity and the vaginal tunic. The intervening cavity is narrow. It often coexists with congenital hernia.

Encysted Hydrocele.—In this form the serum is contained in a cyst, commonly in connection with the epididymis.

Hydrocele of the Cord is due to the presence of fluid in the loose connective tissue of the spermatic cord. It is not always encysted, and communicates with neither peritoneal cavity nor sac of tunica vaginalis.

Hæmatocele.

Hæmatocele is a collection of blood in the tunica vaginalis. The swelling is globular or pyramidal, and is opaque and tense. It is occasioned either by a blow or wound. It may result from incautious use of an instrument, as in tapping for hydrocele.

Treatment.—Inflammation should be combated and the absorption of the blood encouraged. It may become necessary to open the sac by free incision, turn out the clot, and allow the surface to granulate.

Varicocele.

Varicocele or circocele is a varicose condition of the veins of the spermatic cord. It is commonly confined to the left side, owing

to the fact that the left spermatic vein is longer than the right, and not so direct in its course; and to the absence of a valve at the point of its entrance into the renal vein. The disease is rarely seen before puberty. It is caused by anything that tends to impede the venous circulation in the parts, such as wearing an ill-adapted truss for hernia, constipation, masturbation, horseback riding, etc. When well-developed, it presents itself as a convoluted knotty mass of enlarged veins, which moves readily under the finger. The vessels form a tumor of an irregular pyramidal shape, its base being downwards. Its size is influenced by position.

The SYMPTOMS of varicocele are sensation of weight in the part, with dragging sensation in the loins.

The TREATMENT is palliative or radical. The former consists in suspending the scrotum, removing the predisposing cause, and in the frequent use of cold water. The radical plan is to obliterate the trunks of the enlarged veins, and endeavor to induce adhesive inflammation between their coats. This may be accomplished by ligation, compression, the actual cautery, etc.

CHAPTER XIV.

EXCISION OF JOINTS.

EXCISION of a joint is admissible when the structures are hopelessly diseased or injured. It is proposed as a substitute for amputation: a useful limb oftentimes being secured by the removal of the affected parts.

Excision of the Shoulder-Joint.

This operation is performed by making a straight, U, or S incision, commencing half an inch below the clavicle and extending through the deltoid muscle. The sides of the incision are then retracted to expose the joint. The long head of the biceps should be slipped out of its groove and held to one side for protection. The tendons, inserted into the tuberosities, are next divided, and the head brought out of the wound. If the articular surface be alone affected, the gouge should be used in removing the diseased structure; if, however, a ball be lodged in the head of the bone, or the structure be extensively diseased or comminuted, all implicated parts are to be removed by the saw. The glenoid cavity should be similarly treated. The flaps should be brought together in the ordinary method, and the arm supported by a sling.

Excision of the Elbow-Joint.

This is an operation which is frequently performed for scrofulous disease and gunshot injury, and which has been attended by excellent results. An incision is made across the posterior part of the joint, immediately above the olecranon, from epicondyle to epitrochlea, which may be afterwards joined by vertical ones along

the sides. The ulnar nerve being drawn inwards to avoid its injury, the joint is opened and the articular surfaces freely exposed, by forcibly bending the joint and pushing the forearm upwards. The affected structures are now excised, so far as is possible retaining the points of insertion of the flexor muscles. The chain saw is advantageously used in removing the diseased portions. When the ordinary saw is employed a spatula should be inserted beneath the bones for the protection of the soft parts. The limb should be placed in a flexed position, and the parts allowed to rest in juxtaposition. Passive motion should be attempted during the latter part of the treatment to prevent anchylosis.

Excision of the Knee-Joint.

The leg being flexed upon the thigh, a curved incision is made across the upper part of the leg from one condyle to the other below the lower extremity of the patella. The ligaments are then divided and the parts turned out. A fold of cloth is then passed through the joint and drawn firmly under the extremity of the bone to be sawn, thus protecting the soft parts behind. Some operators prefer the H incision, as in the elbow. During the after-treatment the limb should be permanently extended, and especial pains be taken to secure free drainage of pus from the wound. The difficulty in obtaining this is a frequent source of failure.

Excision of the Hip-Joint.

This operation has been performed for chronic disease, and peculiar forms of gunshot injury. A longitudinal, T shaped, or, what is perhaps preferable, a semicircular incision, should be made over the great trochanter. The articulation having been exposed and the ligaments divided, the leg should be strongly adducted, rotated inwards, and pushed upwards, the superior extremity of the bone being thrust through the opening. The soft parts are protected by spatulas or cloths, and the diseased portions removed by a narrow saw. The chain saw is often used with advantage. Should portions of the acetabulum be diseased, they should be removed with the gouge. The bleeding is trifling. The limb should be extended and maintained in that position by a permanent dressing. Of 87 excisions of the hip-joint for injury, performed in the United States, 8 have been followed by recovery.

CHAPTER XV.

AMPUTATION.

General Considerations.

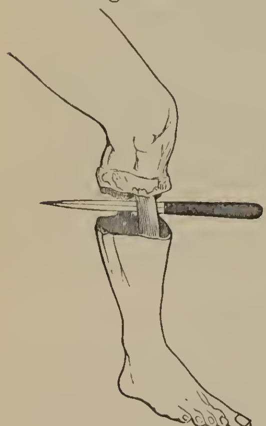
AMPUTATION becomes necessary when, from the progress of disease, or effects of injuries, a limb or portion of limb is rendered irremediably useless, and may endanger life by its longer contact with the body. Among the more common conditions requiring

amputation are, a gangrenous state of the soft parts, the presence of malignant tumors, chronic joint disease not amenable to excision, and traumatic injuries involving much comminution and loss of structure.

Amputation may be *primary* or *secondary*.

Primary amputation is so called when the operation is performed immediately after the subsidence of the shock of an injury. Such a procedure is advisable in all traumatic cases, when from the nature of the injuries it is at once apparent that no attempt to save the limb can be successful.

Fig. 393.



CIRCULAR AMPUTATION SHOWN IN THE LEG, THE INTEGUMENTS BEING TURNED BACK, AND THE MUSCLES DIVIDED DOWN TO THE BONE.

Secondary amputation is the operation performed after suppuration has set in. It may be advisable in certain cases to await this event. But ordinarily the primary operation is to be preferred.

Amputation through the shaft of a bone is said to be in continuity; through a joint, in contiguity.

There are two methods of amputation in general use: the circular and the flap.

Circular.—The circular method is performed by dividing the integument and superficial fascia, dissecting up the skin to a distance of two or three inches, according the diameter of the limb, like the cuff of a coat. The muscles are then divided, immediately below the edge of the retracted integument, down to the bone. The muscles surrounding the bone having been separated from it to the distance of an inch or more, and the soft parts protected by a retractor, the saw is applied and the operation is completed.

Flap.—The assistant drawing back the skin from the point of election, the anterior flap is formed by transfixing immediately in advance of the bone. The knife is then inserted at a corresponding point behind the bone and the posterior flap is made. The latter should, as a rule, be somewhat larger than the former.

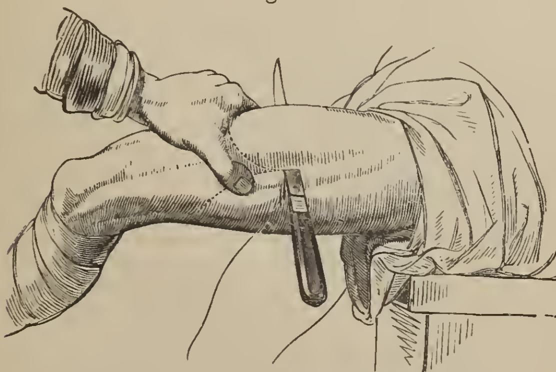
"When the patient is extremely muscular, and the amputation has been done in the arm, thigh, or leg, it will be found to be most convenient to save skin flaps, made by cutting from without inwards, dissecting up the integuments from the fascia to a sufficient extent, and then making a circular cut through the muscles down to the bone, thus only leaving a skin covering."

The following rules should be observed in conducting an amputation :—

In the adult male the parts from which it is proposed to secure the flaps should be shaved, the limb elevated for a few moments prior to the operation, and, in order to rid the limb of blood as

much as possible, pressure may be made along the lines of important vessels in a direction from the extremity towards the trunk. The tourniquet should be applied over the point upon which it is desired to make compression; but the screw is not to be tightened until the surgeon is entirely ready to begin the operation. The

Fig. 394.



AMPUTATION OF THE THIGH BY THE FLAP METHOD.

patient should be brought under the influence of an anæsthetic (ether is the safest), whose effects should be watched, and maintained so long as required, by a competent assistant. If chloroform be employed, it should be well mixed with air as it is breathed. Some surgeons prefer a mixture of one part alcohol, two parts chloroform, and three parts ether, for inhalation. For pure chloroform, the best method is, to lay a handkerchief, single, over the face of the patient, and pour the chloroform, *drop by drop*, upon the middle of it. With ether, a conical hollow sponge, or a towel folded into the shape of a cone, is commonly used. The saw should be stout, but not too heavy. It should always be drawn from the heel to the point in starting the groove. When two bones are present in the limb, the smaller and less fixed of the two should be severed first. After the removal of the limb, the larger arteries should be secured before the screw of the tourniquet is loosened. As a rule the tenaculum is more convenient for this purpose than the forceps.—Sponges are intended to absorb the blood, and not to wipe or scrub the flaps. They should be small, and of fine quality.—It is advisable to allow the stump to remain open until the surface glazes, when its sides may be loosely approximated by sutures. But these should not be accurately adjusted for several hours after the operation, in order to preclude the necessity of their rough handling in the not unfrequent event of some neglected vessel spirting during the period of reaction from the anæsthetic.

In 1873, Professor Esmarch, of Kiel, in Germany, introduced the method of preventing hemorrhage during amputations by firm

compression of the limb with India-rubber. The patient being anæsthetized, first a bandage of India-rubber webbing is drawn around the limb from below upwards, as far as the place of amputation; and then India-rubber tubing is wound around the portion above, tightly, several times, and its ends secured together by hooks and rings. The limb is thus made bloodless during the operation.[1]

Amputation of the Fingers.

A finger may be amputated either at a joint or in continuity. When the terminal phalanx is necrosed, it may be removed by a lateral incision: the pulp and finger-nail are left, forming a useful point to the finger. The ordinary operation, through an articulation, is performed after strongly flexing the member, by making a short, semilunar incision from one side of the finger to the other on its dorsal surface, the convexity presenting towards the nail. The joint being opened, the other flap is made from the palmar surface. When the circular method is adopted, as in amputation through the shaft, an incision should be made through the skin, which is retracted three or four lines, and, the fibrous tissues having been divided, the bone is either sawn or cut through with bone nippers.

Amputation at the metacarpo-phalangeal joint is best performed by the oval method. The finger is to be forcibly flexed and an incision made on the dorsal aspect of the joint, a short distance above and carried down to the commissure. It is then carried across the fold and beneath the finger, to be brought up through the web of the opposite side to the spot where it commenced. Should it appear likely that the head of the metacarpal bone would be unduly prominent, it may be removed by bone forceps.

The thumb may be amputated by the oval method, by making an incision along the dorsal surface of the metacarpal bone of the thumb, commencing six lines above its articulation, passing around the web, and returning to the point of starting; or by the single flap method, in which the knife divides the web between the thumb and index finger, down to the carpo-metacarpal articulation. The joint is then opened, the bone disarticulated, and the flap formed by cutting gradually outwards along the side of the bone a short distance beyond the metacarpo-phalangeal joint. It is of importance to remember that in operations about the hand we should retain as much of the tissues as possible.

Amputation at the Wrist.

This may be performed by the flap or circular methods. The flap method consists in making a semilunar incision with its convexity downwards from one styloid process to the other, cutting from without inwards. The hand being forcibly flexed the flap is raised, the tendons and ligaments divided, the joint opened, and a corresponding flap made from the palmar surface. In the circular method, the incision is made about an inch below the styloid pro-

[1] A very similar practice was tried and abandoned (with ordinary bandage instead of rubber) in this country, many years since.

cesses, the skin is dissected and turned back to the level of the joint, which is opened and the hand removed. The styloid processes are best cut off on a level with the rest of the articular surface.

Amputation of the Forearm.

By the flap method, this is performed by holding the forearm in a position midway between pronation and supination, when the tissues, on either side, are transfixed close to the bones. The interosseous membrane is then divided, and the bones sawed—the soft parts being protected by linen retractors.—In the circular method, the tissues of the limb being drawn upwards by an assistant, the parts are divided by the first incision down to the deep fascia, the skin and superficial fascia are then turned up to the extent of an inch, and the muscles divided by a circular sweep of the knife. A lateral incision may be necessary in raising the flap if the arm be unusually conical.

Amputation of the Arm.

The arm is usually amputated by the double flap operation. The soft parts being firmly grasped and held away from the bone, the limb is transfixed from the front, and a flap is made from two and a half to three inches in length. A similar flap being secured from the posterior part of the arm, the bone is sawed. The combination of skin flaps with circular division of the muscles is advisable where, from the extreme muscularity of the parts, the flap might prove redundant.

Amputation at the Elbow-Joint.

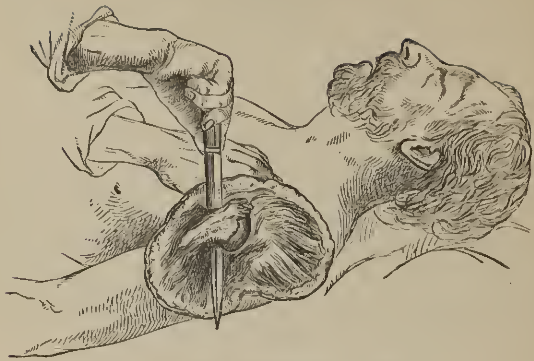
This is performed by making a single long flap from the anterior part of the arm, fashioned from without inwards. The joint having been opened from the front, the radius is disarticulated and the olecranon process sawed through, thus retaining the insertion of the triceps.

Amputation at the Shoulder-Joint.

This may be effected by transfixion, or by the oval method. That by transfixion is performed by abducting the arm, and passing the knife in at the inferior margin of the axilla, to be brought out about half an inch beneath the clavicle, just beyond the acromion process. This flap includes nearly the whole of the deltoid muscle. The head of the bone then being disarticulated, the internal flap is made by cutting from within outwards. This flap, containing, as it does, the vessels, the assistant should be prepared to compress immediately upon the limb being removed.

In the oval method, a vertical incision is made on the outer surface of the shoulder, starting from the acromion process and terminating one inch below the top of the humerus. Two oblique incisions start from this one, running around the upper extremity of the humerus to the middle of the axilla, the other extending along the posterior and outer aspect of the shoulder to join the first in the armpit. The edges of the wound being separated, the

Fig. 395.



AMPUTATION AT THE SHOULDER-JOINT.

joint is opened, and the remaining tissues, including the blood-vessels, are divided from above downwards.

Amputations of the Toes.

The toes and their phalanges may be amputated in the same way as the corresponding parts of the hand.

Lisfranc's Operation.

Amputation of the tarso-metatarsal junction (Lisfranc's operation). The tubercle of the fifth metatarsal bone and the projection of the scaphoid forming the guide, a semilunar incision, with its convexity looking downwards, is made across the dorsum of the foot a short distance in front of the articulation. The dorsal ligaments having been divided, disarticulation is next effected, and a long flap is cut from the sole of the foot. In disarticulating it should be remembered that the head of the second metatarsal bone is sunk between the internal and external cuneiform bones. Hey's operation is the same as the above, with the exception that the bones are sawed across at the junction of the flaps.

Fig. 396.

CHOPART'S AMPUTATION.

Chopart's Amputation.

Amputation through the tarsus (Chopart's operation). This operation consists in disarticulating between the astragalus and calcaneum, scaphoid and cuboid bones. A short

flap is made in front of the foot, beginning midway between the outer malleolus and head of the fifth metatarsal bone, and terminating directly opposite on the inner margin of the foot. This being turned back the articulation is opened, when a long flap extending as far forward as the base of the great toe is cut from the plantar surface by transfixion.

Syme's Amputation.

Amputation at the ankle-joint (Syme's amputation). Two flaps are made in the performance of this operation, an anterior and a posterior. The line of the posterior flap is made by incising the skin and fascia across the sole of the foot from one malleolus to the other. The anterior incision should join this in a straight line down across the instep. The posterior flap should then be dissected up, the knife keeping close to the calcaneum, care being taken to avoid injuring the posterior tibial vessels which run within its inner portion. The anterior flap is next raised, the foot disarticulated from in front, and the malleoli removed by the saw.

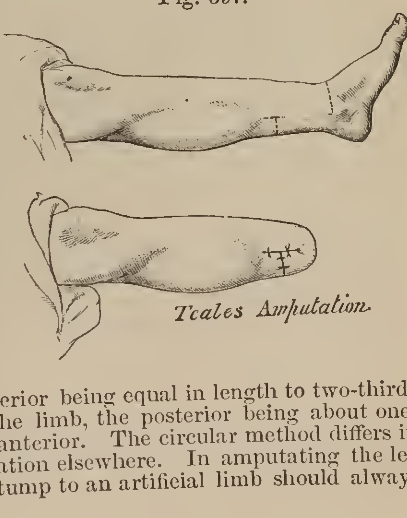
Pirogoff's Amputation.

Pirogoff's modification of the above operation consists in retaining in the posterior flap a segment of the os calcis, which being opposed to the sawn surfaces of tibia and fibula, will, under favorable circumstances, unite with them.

Amputation of the Leg.

This is performed by either the flap or the circular methods. If by the former, the knife is made to transfix the calf close to the bones, and a flap is cut from four to five inches in length. An anterior flap of equal dimensions is then fashioned, and the bones divided, as in amputation of the forearm. In sawing the bones the fibula should be divided first to avoid splintering. A valuable modification of the flap operation is made by using skin flaps of the same size as those described, the muscles being subsequently divided by a circular incision. Teale's operation consists in making two rectangular flaps, the anterior being equal in length to two-thirds of the circumference of the limb, the posterior being about one-fourth the length of the anterior. The circular method differs in no respect from the operation elsewhere. In amputating the leg the adaptability of the stump to an artificial limb should always

Fig. 397.



Teales Amputation

be a subject for the consideration of the surgeon. When circumstances allow of a choice, the "place of election" is generally fixed at four inches below the patella. The leg should never be amputated nearer the knee than the tuberosity of the tibia.

Amputation at the Knee-Joint.

This is best performed by the double flap method. The anterior flap is cut from without inwards, and extends from the origin of the hamstring muscles on either side, downwards to two and a half inches below the head of the tibia. The ligament of the patella is then divided, the flap raised, and disarticulation effected. The posterior flap is made by cutting downwards and outwards through the upper portion of the gastrocnemius muscle.

Amputation at the Thigh.

This may be performed at the lower, middle, or upper third of the thigh. Either the circular or flap method may be employed, though the latter is generally preferred. The soft parts having been forcibly raised by the thumb and first finger, the knife is thrust through the tissues from the outer to the inner aspect of the limb immediately above the bone, and a flap from three to four inches in length is cut from within outwards. The knife is then again introduced, and passing under the bone a posterior flap is made a little longer than the anterior. Flaps have been made from the sides of the limb—Vermales' method. An objection to this is seen in the tendency of the end of the bone to rise at the upper angle of the wound and to protrude forwards.

Amputation at the Hip-Joint.

The flap method is here most generally preferred. The buttock being brought well over the edge of the table, the knife is passed obliquely through the thigh immediately in front of the joint, entering, if it be the left limb, below the tuberosity of the ischium, and emerging at a point midway between the anterior superior spinous process of the ilium and the great trochanter. The external flap, which must be at least four inches in length, is now formed by the knife passing downwards and outwards in close contact with the bone. The capsule is next opened, the head disarticulated, and the blade of the knife carried round the bone, and the internal and anterior flap, which must be longer than the external, fashioned. An assistant should firmly compress the anterior flap the moment division of its vessels takes place. Before this, the femoral artery may be compressed at the groin; or use may be made of Lister's aorta-compressor, or of the abdominal tourniquet.

CHAPTER XVI.

CLUB-FOOT.

CLUB-FOOT is a peculiar distortion of the foot, for the most part congenital, characterized by "deviation from its natural direction, and also, generally, a diminution of its proper length." Originally occasioned by loss of antagonism between the different

Fig. 398.

Talipes Equinus.

Fig. 399.

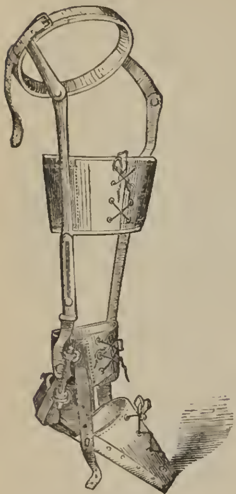
muscles of the leg, the condition is ordinarily maintained by excessive contraction of those muscles placed in connection with that region toward which the deformity tends. Thus, in *talipes varus*, where the foot is inverted, its inner margin being inclined up-

Fig. 400.

Congenital Varus.

wards, and the plantar surface looking inwards and upwards, the defection is chiefly due to the action of the anterior tibial muscle. In *talipes valgus*, where the foot is everted, the inner margin turned downwards, and the plantar surface directed upwards and outwards,

Fig. 401.



Clup-foot Apparatus.

the peroneal muscles are at fault. This variety is often associated with flat-foot. *Talipes equinus*, where the heel is markedly elevated, the gastrocnemius and soleus are to be accused; as, on the other hand, in *talipes calcaneus* are the anterior tibial and common extensor muscles. The affection is said to be more frequent with boys than girls. The most common variety is the *talipes varus*, the least frequent *talipes calcaneus*. The influence of such deformities upon progression are so apparent as to require no comment.

Treatment.—When the condition is marked the operation of tenotomy should be practised. This consists in dividing subcutaneously the affected parts by means of a tenotome. The tenotome recommended by Prof. Gross "is nearly six inches in length, of which one inch and three-quarters are occupied by the blade. The cutting portion of the blade is spear-shaped, very sharp, thin, and a little more than five-eighths of an inch in length, by two-thirds of a line in width at its widest part." The knife is introduced sideways, and then the edge is turned down and carried through the tendon. The knife is then withdrawn, and the incision closed with a piece of plaster. The patient will have to wear a mechanical contrivance adapted to the case, for some time after the operation. The modified shoe of Scarpa (Fig. 401) is the one commonly recommended for this purpose.

CHAPTER XVII.

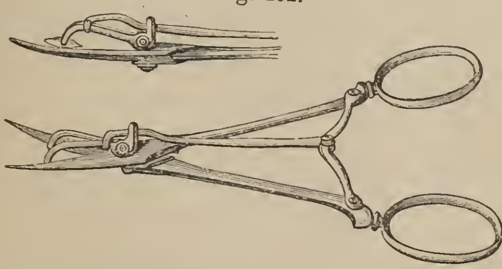
SKIN GRAFTING.

Suggested probably by John Hunter's observation that the spur of a cock would grow when transplanted to the comb either of its own head or that of another bird, and also by the success of what are called *plastic* operations, Reverdin,[1] in 1869, proposed skin-grafting to promote the healing of large ulcers, old burns, etc. Pollock and many others have followed this practice successfully.

[1] Prof. F. H. Hamilton, of New York, introduced a similar practice at a still earlier date.

With a small pair of curved scissors,[1] a section of skin is taken from the arm or side of the chest; including only the outer layer of the true skin, not cutting deeply enough to draw blood or give

Fig. 402.



positive pain. The section may then be divided into smaller pieces, and these are to be placed upon the sore, half or three-quarters of an inch from its margin, and about an inch apart.

Fig. 403.

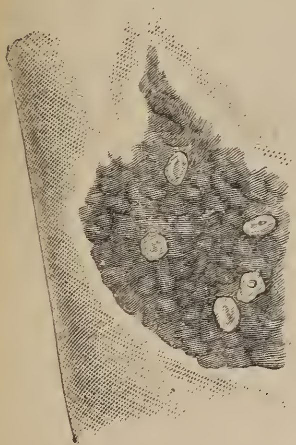


Fig. 404.

They require to be merely pressed in very gently, and covered with oiled silk, supported by a bandage. The dressing must be changed with great care, not sooner than the third day. Only tepid water, without any sponging or wiping, is allowable to cleanse the surface.

[1] Another method, devised by Dr. C. H. Thomas, is, to raise a point of skin by a nearly horizontal puncture with a needle, and then cut the raised portion off with a small knife or scissors.

When the new centres of growth have become established, if the sore be very large, still others may be inserted in like manner. The rapidity of the granulation and healing of extensive and obstinate ulcers is thus sometimes much promoted.

Skin dust, obtained by scraping the skin, is also employed, as proposed by M. Sée ; but it is less often successful. Under either practice, the new skin is apt to be more delicate and easily destroyed than the old, requiring considerable care and protection during and after recovery.

A MANUAL

OF

OBSTETRICS.

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OBSTETRICS.

CHAPTER I.

THE OBSTETRIC PELVIS.

THE BONES.

THE pelvis is an irregular bony cavity, situated at the base of the spinal column, and above the inferior extremities. In the adult it is divided into four parts, or bones, viz. : *two ossa innominata*, the *os sacrum*, and the *os coccygis*.

Ossa Innominata.

Prior to the age of puberty, each os innominatum consists of three divisions, the *os ilium*, the *os ischium*, and *os pubis*, which

Fig. 405.

OS INNOMINATUM, INNER SURFACE.—1. Rough iliac surface of sacro-iliac junction. 2. Ascending ramus of ischium. 3. Spine of pubis. 4, 5. Anterior superior and inferior spinous processes of the ilium. 6, 7. Posterior superior and inferior spinous processes of the ilium. 8 Sciatic notch. 9. Inclined plane of ischium. 10, 11. Venter of ilium 12. Linea ilio-pectinea. 13. Spine of the ischium. 14. Tuberosity of the ischium. 15. Internal surface of the ischium. 16. Descending ramus of pubis. 17. Symphysis pubis. 18. Ilio-pectineal eminence. 19. Groove for obturator vessels and nerve. 20. Obturator foramen.

are connected by a Y shaped cartilage in the acetabulum, two-fifths of the latter being formed by the ilium, two-fifths by the ischium, and one-fifth by the pubes.

The *os ilium* is the largest of the three divisions of the os innominatum, is triangular in shape, situated superiorly, and, with its fellow, forms what is called the *false pelvis*.

Its external surface or dorsum is convex and irregular, with elevations and depressions which serve for the attachment of the glutei muscles. Its internal surface or venter is concave and smooth, affording a bed for the iliacus internus muscles. The lower portion, body, or base is the thickest part of the bone, and enters into the formation of the acetabulum.

Fig. 406.

Os Innominatum. Outer Surface.—1. Dorsum ilii. 2. Body of ischium, forming part of acetabulum. 3. Venter ilii. 4, 5. Anterior superior and inferior spinous processes. 14. Tuber ischii. 15. Acending ramus of ischium. 16. Horizontal ramus of pubis. 18. Descending ramus. 19. Groove for obturator vessels and nerve. 20. Obturator foramen.

Above the body, the bone spreads out into its *ala*, or wing, whose superior border is termed the crest, or *crista ilii*, which serves for the attachment of the abdominal muscles. The two projections at the anterior portion are the *anterior superior and anterior inferior spinous processes*. To the former Poupart's ligament is attached. Posteriorly are situated the *posterior superior and posterior inferior spinous processes*, and below these is a deep arch, the *sciatic* or *sacro-sciatic notch*, which is divided by ligaments into the two sciatic foramina. The posterior part of the crest of the ilium is an irregularly oval, rough surface, with numerous prominences which occupy corresponding depressions in the sacrum. The body of the bone is divided from the ala internally

by a well-marked ridge running forwards from the junction of the ilium with the sacrum, called the *linea ilia*, which is a part of the *linea ilio-pectinea*.

The *os ischium* is the lowest division of the os innominatum. Its body or base is the thickest portion; below this is a narrower portion, from which a spinous process juts out and affords insertion to a part of the sacro-sciatic ligament. This process varies in length and direction, and is occasionally of great obstetrical importance. From the neck, the bone descends until it terminates in a thick, rough protuberance called the *tuber ischii*, and turning upwards it becomes the *ascending ramus* of the ischium. Its internal surface is smooth and even, and forms one of the inclined planes of the pelvic cavity. Its external surface is rough, and gives attachment to the sacro-sciatic ligament and to various muscles.

The *os pubis* is the smallest and most anterior of the three bones. It consists of a body or base, which is its thickest part, and a *horizontal ramus* and *descending ramus*. The latter, with its fellow, constitutes the *arch* of the *pubes*. The inside edge of the horizontal ramus is the *linea pectinea*, and forms part of *linea ilio-pectinea*. Near its pubic termination is a small spinous process, to which is attached the inner end of Poupart's ligament.

Os Sacrum.

The *os sacrum* terminates the vertebral column. It is of a triangular shape, the base of the triangle being upwards. Its length is from four to five inches, its breadth four inches, and its greatest thickness two and a half inches. It is the lightest bone of its size in the body. Its external surface is rough and convex, and has four or five small spinous processes resembling those of the vertebræ. Anterior to these we find the continuation of the spinal canal, containing the *cauda equina;* with four foramina on each side communicating with it, for the transmission of nerves.

Fig. 407.

Os Sacrum.—1. Promontory of sacrum. 2. Hollow of sacrum. 3. Articulating surface of sacro-iliac symphysis. 4. Coccyx.

Its *internal surface* is smooth and concave, and is crossed by four transverse lines, marking the former division of its bones by cartilage; here also are four foramina, sloping outwards, through which pass filaments that afterwards form part of the great sciatic nerve. The upper portion, or base, projects forwards and forms the *promontory of the sacrum.* The lateral surfaces are

rough and uneven, the irregularities corresponding to similar ones in the ilium. Obstetrically considered, this is a very important bone, inasmuch as it enters largely into the various deformities of the pelvis.

Os Coccygis.

The *os coccygis* terminates the sacrum and vertebral column. Its form is pyramidal, the apex of the pyramid being below. It consists of three or four bones, movable upon each other by a ginglymoid joint.

The two last lumbar vertebræ are sometimes reckoned among the bones of the pelvis. They form, with the sacrum, the *sacro-vertebral angle.*

The Symphyses of the Pelvis.

The articulations of the pelvis are four in number, called the *symphyses:* viz., the *symphysis pubis*, the two *sacro-iliac symphyses*, and the *sacro-coccygeal symphysis*, to which may be added the *sacro-vertebral* joint.

The *symphysis pubis* is situated anteriorly, and is formed by the junction of the two *ossa pubis*, whose extremities are covered with thin plates of fibro-cartilage. The posterior two-thirds of the latter are lined with synovial membrane, and thus is formed a true arthroidal articulation. This joint is strongly fortified by ligaments, viz., the *anterior*, *posterior*, *superior*, and *sub-pubic ligaments.*

The *sacro-iliac symphysis* of either side of the pelvis consists of a rough, irregular surface on the posterior part of the ilium and on the side of the sacrum, each of which is covered with a layer of fibro-cartilage. The union of these two bones is strengthened by strong ligamentous bands which stretch across from one bone to the other, and, from their position, are termed the *anterior* and *posterior sacro-iliac* ligaments. Additional strength is gained by the sacro-sciatic ligaments connecting the lower part of the sacrum with the ilium, and by the ilio-lumbar ligaments connecting the ilium with the lower lumbar vertebræ. The sacro-iliac joint is rendered immovable unless great force is employed, and separation, to any extent, of the symphysis pubis, can be effected only by the rupture of both the pubic and sacro-iliac ligaments, an accident which never occurs during labor.

The *sacro-coccygeal symphysis* is formed as follows: The articulating surface of each bone is covered with cartilage lined by a synovial membrane, making a ginglymoid joint which is surrounded by a strong fibrous ligament. It possesses extensive motion, especially backwards. It may become anchylosed, and offer a decided impediment to labor during the passage of the head through the outlet.

Divisions of the Pelvis.

The pelvis is divided by the linea-ilio-pectinea into the upper and lower, or the *false* and *true pelvis.* The upper or *false pelvis* is formed by the lateral divulgence of the alæ of the ossa innominata. It does not possess much obstetrical importance, the lower or *true*

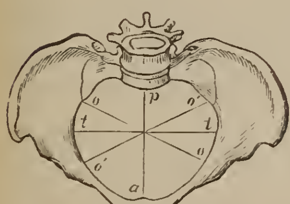
pelvis being the part involved in parturition. The latter, for accuracy of description, is divided into the *brim*, *inferior strait*, and the *cavity*. The *brim*, or *superior strait*, is defined by the linea-ilio-pectinea ; it is of an oval form, except posteriorly, where the oval is broken by the promontory of the sacrum.

It has three principal diameters, viz. : the *antero-posterior*, extending from the promontory of the sacrum to the upper and inner edge of the symphysis pubis ; the *transverse*, across the widest part of the brim, at right angles to the antero-posterior ; and the *oblique*, from the sacro-iliac symphysis of one side to the opposite side of the brim of the other, just above the acetabulum. According to Hodge, the antero-posterior diameter is four inches ; the transverse, five and a quarter inches ; and the oblique, five inches.

The *outlet*, or *inferior strait*, is of an oval shape, but irregular. Its antero-posterior diameter from the subpubic ligament to the point of the coccyx is four inches, but distensible to four and a half inches by the mobility of the coccyx ; the transverse from one tuber ischii to the other is about four inches.

The *cavity* of the pelvis is the space between the superior and inferior straits. It measures, according to Hodge, posteriorly, five inches in depth ; from the brim to the tuber ischii, three inches and a half; and the depth of the symphysis pubis is about one and a half inches. The diameters of the cavity of the pelvis are as follows : antero-posterior, four inches and three-quarters ; transverse, four inches and three-quarters ; oblique, six inches.

Fig. 408.



DIAMETERS OF SUPERIOR STRAIT.—*t*, *t*. Transverse. *a*, *p*. Antero-posterior. *o*, *o* Left oblique. *o'*, *o'*. Right oblique.

Fig. 409.

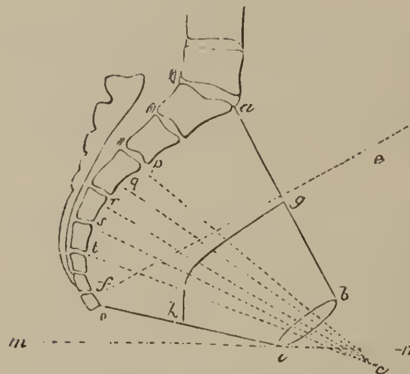
DIAMETERS OF THE INFERIOR STRAIT.—*a*, *p*. Antero-posterior. *t*, *t*. Transverse.

The *plane* of the superior strait is represented by a piece of card paper fitted to the brim of the pelvis, and one fitted to the outlet will represent that of the inferior strait. Any number of planes of the cavity of the pelvis, may be illustrated in like manner.

A line running from the coccyx to the umbilicus will pass perpendicularly through the centre of the plane of the superior strait, and form the *axis* of said strait ; while a perpendicular line running from the promontory of the sacrum through the centre of the

plane of the inferior strait will form the axis of that strait. A line drawn in the same manner in respect to any plane of the cavity of the pelvis will be the axis of that plane.

Fig. 410.



PLANES AND AXES OF THE PELVIS.—*a*, *b*. The plane of the superior strait. *o*, *i*. The plane of the inferior strait. *c*. The point where these two planes would meet if prolonged. *pc*, *qc*, *rc*, *sc*, *tc*. Planes of the cavity of the pelvis. *e*, *f*. The axis of the superior strait. *g*, *h*. The axis of the pelvis. *m*, *n*. The horizontal line.

When all the axes of the planes of the cavity are connected they form a *curve* which is called the *axis of the pelvis*. This curve, sometimes named "the curve of Carus," is greatest at its lower portion, and is very correctly represented by the curve of the male catheter.

It will be seen that the axis of the superior strait does not coincide with that of the body, but forms, with the latter, an angle of from 50° to 60°. This *obliquity* of the pelvis, as well as the *curvature* of the *axis* of the pelvis, should receive the student's careful attention.

The Pelvis modified by Sex.

The female pelvis is broader and more shallow than that of the male. Its superior strait is more elliptical; the sacrum less curved; the tuberosities of the ischia are wider apart, and the ischio-pubic branches form a broader arch at their junction.

CHAPTER II.

ORGANS OF GENERATION.

THESE are divided into the *external* and *internal*. The former are the *mons veneris*, the *labia majora* and *minora*, the *clitoris*, and *hymen;* the latter are the *vagina*, *uterus*, *ovaries*, and *Fallopian tubes*. The mammæ are sometimes classed among the organs of generation.

External Organs.

The *mons veneris* is a triangular, cushion-like prominenee, situated over and above the symphysis pubis. It consists of a thick layer of areolar and adipose tissue covered by skin, upon which, at puberty, a quantity of hair makes its appearace, having among its roots numerous sebaceous follicles.

The *labia majora* or *externa* consist of two folds of skin externally, and mueous membrane internally, extending downwards from the *mons veneris*. They are thieker and wider above, gradually deereasing as they descend. Externally, they are thinly eovered with hair. Their junetion above is called the anterior commissure, and below, the posterior commissure or fourehette.

Fig. 411.

EXTERNAL ORGANS OF GENERATION.

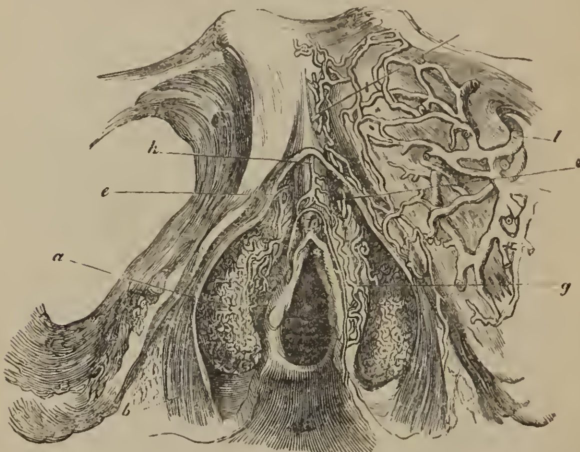
The external labia contain, between the skin and mueous membrane, areolar and adipose tissue, nerves, bloodvessels, and glands.

The *labia minora*, or *nymphæ*, are two lateral folds of mucous membrane internal to the labia majora. They extend from the anterior superior portion of the vulva to about the middle of the orifice of the vagina, and eontain between their mueous coats a spongy vascular tissue and nerves. They enfold the clitoris and the meatus urinarius, and cover part of the vaginal orifice. They are, like the external labia, elastie and distensible, yielding with more or less readiness to the passage of the child's head at birth.

The *clitoris* is the analogue of the male penis, but has no urethra, and no eorpus spongiosum. It is highly sensitive, vascular, and capable of ereetion. It is situated just below the junction of the nymphæ.

Below the clitoris is a smooth triangular space—the vestibule—at the lower part of which is the *orifice of the urethra*, or *meatus urinarius*, just at the upper edge of the orifice of the vagina.

Fig. 412.



FRONT VIEW OF THE ERECTILE STRUCTURES OF THE EXTERNAL ORGANS OF GENERATION.—*a*. Bulbus vestibuli. *b*. Sphincter vaginæ muscle. *e*, *e*. Venous plexus, or pars intermedia. *f*. Glans of the clitoris. *g*. Connecting veins. *h*. Dorsal vein of the clitoris. *k*. Veins going beneath the pubes. *l*. The obturator vein.

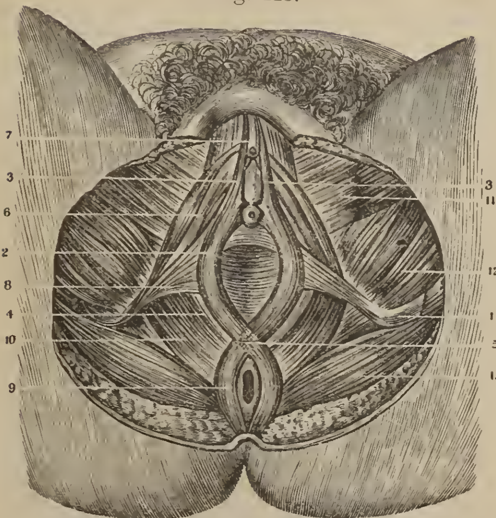
The *urethra* is a dilatable membranous canal, about an inch and a half in length, running under and behind the symphysis pubis to the urinary bladder.

Below the urethra and stretching across the inferior portion of the orifice of the vagina is a slight crescentic fold of mucous membrane called the *hymen*. It is usually, but not always, ruptured by sexual intercourse. It is sometimes absent, from disease and other causes independent of coition. Great care in diagnosis is therefore necessary in regard to it.

The *carunculæ myrtiformes* are the remains of the hymen after its rupture. The *fourchette* is the inner edge of the posterior commissure, and consists of a fold of mucous membrane which is generally slightly torn in first labors.

The space between the posterior commissure and the anus is called the *perineum*, which is composed of skin, adipose and areolar tissue. In connection with the constrictor vaginæ, levator ani, transverse and sphincter muscles, it serves to partially close the outlet of the pelvis and prevent the prolapse of the viscera. Though elastic and distensible, it is sometimes, yet rarely, ruptured during the passage of the child. The external organs are collectively called the *pudendum*.

Fig. 413.



A VIEW OF THE MUSCLES OF THE PERINEUM IN THE FEMALE.—1. Tuber ischii. 2. Sphincter vaginæ muscle. 3. Its origin from the base of the clitoris. 4. Vaginal ring of the same muscle, which receives a part of the fibres of the levator ani. 5. Inter-crossing of the sphincter ani and sphincter vaginæ muscles at the perineal centre. 6. Erector clitoridis muscle. 7. The clitoris covered by its prepuce. 8. Transversus perinei muscle. 9. Sphincter ani. 10. Levator ani. 11. The gracilis. 12. Adductor magnus. 13. Posterior part of the gluteus magnus.

Figs. 412 and 413 will assist in giving the student a good idea of the anatomy of the external organs of generation.

Internal Organs of Generation.

The vagina is a musculo-membranous canal four or five inches long, extending in the direction of the axis of the pelvis, from the vulva up to the neck of the uterus which it embraces. It has three coats, the internal or mucous, the middle or muscular, and the external or areolar. The mucous coat has transverse folds or rugæ, which by unfolding permit the distension of the vagina. The middle coat is made up of longitudinal, oblique, and circular fibres. The latter are more numerous near the orifice, and constitute the constrictor vaginæ.

The external coat connects the vagina anteriorly with the urethra and bladder, and posteriorly with the rectum, except at its upper end, which is covered with peritoneum. The *uterus* is pear-shaped and somewhat flattened anteriorly. Its upper portion is called the *fundus;* its middle, the *body;* and its lower, the *cervix.* The length of the whole viscus is about two and three-quarter

inches, its greatest breadth about two and a quarter, and its thickness about one and a quarter inches. Its weight before child bearing is a little less than an ounce; after child bearing, about an ounce and a half. It is situated in the centre of the pelvis, and is bounded above by the small intestines, below by the vagina, in front by the bladder, and behind by the rectum.

Fig. 414.

Section of the Pelvis.

It is a hollow organ. Its entrance at the lower portion is called the *os uteri* or the *os tincæ*, which in some is transverse, in others circular and in others still it is triangular, especially in those who have borne children.

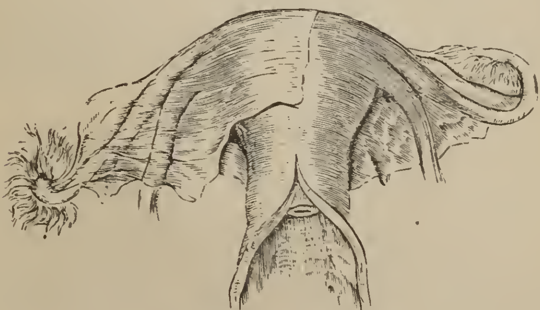
The *canal of the cervix* is about one inch long, narrow at the external os, widest in the middle, and narrow where it enters the cavity, marking the *os internum*. Between the external os and the internal, the mucous membrane is thrown into folds, which branch out from a central line and form the *arbor vitæ*. The cavity of the uterus is triangular, its base being upwards. The walls of the uterus are composed of three coats, the external or peritoneal, the middle or muscular, and the internal or mucous.

The external covering consists of the peritoneum, which is reflected from the abdominal parietes over the fundus and posterior wall of the bladder down to the commencement of the cervix uteri; from whence it passes over the anterior surface, fundus, and posterior surface of the uterus and down the posterior wall of the vagina to an inch below the level of the os uteri, whence it is reflected upon the rectum. The anterior and posterior folds of the peritoneum are reflected laterally to the sides of the pelvis,

and form the *broad ligaments* of the uterus, which contain the Fallopian tubes, ovaries, and round ligaments.

The middle coat of the uterus is composed, according to Virchow and others, of fusiform nucleated fibres imbedded in connective tissue. These fibre cells are about $\frac{1}{4000}$ of an inch in breadth, and though quiescent under ordinary circumstances, are developed under the stimulus of pregnancy into non-striated involuntary

Fig. 415.



UTERUS AND APPENDAGES.

muscular fibres, of which there are three layers in the gravid uterus. The external layer is thin, and consists of transverse and longitudinal fibres. The middle layer is thick, composed of bundles of fibres running in all directions, interlacing with each other, and surrounding the vessels of the uterus. The internal layer is thin, and made up of circular and transverse fibres, which are found around the middle of the body, around the Fallopian tubes, and at the os uteri.

The uterus is supplied with blood by four arteries. The two superior, the *ovarian*, arise from the aorta or the emulgent arteries; the two inferior, the *uterine*, are given off by the hypogastric artery. The veins are more numerous than the arteries, and are capable of greater distension. During pregnancy they are enlarged into sinuses. The nerves of the uterus arise from the aortic plexus, and from the hypogastric nerves and plexus, being composed both of spinal and sympathetic nerves. The lymphatics are numerous, though small, in the unimpregnated uterus.

The *Fallopian tubes* are two cylindrical tubes about four inches long, which arise from the upper angles of the uterus, in whose cavity they open obliquely. They are of nearly uniform size for about three and a half inches, when they expand into a somewhat funnel-shaped fimbriated orifice which opens into the cavity of the abdomen. During impregnation this opening is closely applied to the ovary, which is grasped by the fimbriæ, and through the tube pass the spermatozoa in the one direction and the ovule in the other. The tubes share the nerves and vessels of the ovaries.

Ovaries.

The *ovaries* are the essential organs of generation in the female, corresponding to the male testes. They are situated within the folds of the broad ligaments, on each side of the uterus, to which each one is attached by a small fibrous cord, about one inch long, called the *ligamentum ovarii.* They are small, flattened bodies, about an inch and a quarter in length, five-eighths in breadth, and three-eighths in thickness. Their external covering is the peritoneum, underneath which is a dense white fibrous coat called the tunica albuginea. Their internal structure consists of areolar tissue, bloodvessels, and nerves, in the midst of which are imbedded from ten to twenty spherical bodies, varying from the size of a pin's head to that of a pea, which are called *Graafian vesicles*, and will be described in another place.

Round Ligaments.

The *round ligaments* are two small cords which arise from the side of the uterus at the angles, and pass to the sides of the pelvis, then forwards to the inguinal canal, through which they run, and are lost in the groin and adjacent parts. During pregnancy and early labor they probably aid in giving a forward direction to the fundus. They are composed of nerves, absorbents, bloodvessels, fibrous and muscular tissue, the latter being a continuation of uterine fibres.

The uterus is lined by a mucous membrane extending from the os through the neck, cavity, and Fallopian tubes. The portion lining the neck is thrown into rugæ which are thickly studded with numerous follicles, secreting a clear, thick, tenacious alkaline mucus. That portion which lines the cavity of the uterus is about a line in thickness, and of a pale color. Under a lens numerous points are visible, which are the openings of the glands of the mucous membrane. These glands are simply blind tubes about one-thirtieth of a line in diameter, almost straight in the part near the orifice, but very much convoluted and coiled on themselves at their cæcal ends, where they are seated upon and attached to the muscular coat of the uterus. The mucous membrane of the cavity of the uterus has a cylindrical ciliated epithelium, underneath which club-shaped papillæ or villi are everywhere found, each villus consisting of one or two looped bloodvessels and connective tissue, the whole being covered by an epithelium.

Mammary Glands.

The *mammæ* are two hemispherical glands situated over the pectoral muscle on each side, and between the third and seventh ribs. Each gland is covered by a fibrous capsule which dips down into various parts of the gland. The latter consists of numerous tubes, which divide and subdivide until they arrive at the ultimate follicles of which the substance of the gland is composed. These follicles empty themselves into small tubes, which unite with each other, and proceeding in a tortuous course towards the centre of the gland, and becoming larger and larger, terminate in ten or

fifteen milk tubes, which are connected together near the base of the nipple. The ultimate follicles are covered with a layer of epithelial cells in which the secretion of milk takes place. The nipple is placed on the level of the fourth rib and contains erectile tissue, which causes it to become turgid and erect under special stimulus. Around the nipple is a circle of a pinkish hue in the virgin (brownish in other women), the so-called *areola:* in it are numerous sebaceous glands, whose secretion acts as a protective during nursing. The breasts are abundantly supplied with blood by the internal mammary, epigastric, and intercostal arteries. They contain numerous nerves, chiefly branches of the intercostals, also abundant lymphatics, which connect them with the axillæ and other adjacent parts.

CHAPTER III.

MENSTRUATION.

In early childhood there are no marked distinctions either in physical form or moral traits between the two sexes; their dispositions, etc., being almost identical. Sexuality lies dormant, but at a certain age it is suddenly developed, each sex putting on its peculiar characteristics. This age is known as puberty. In the female, at this time, the general form is expanded and rounded, the breasts are developed, the pelvis enlarged, and the organs of generation perfected. At this time also first appears a bloody discharge from the vagina, which, in after life, occurs once a month for many years, and hence is known as the *menses*, *menstrual flow*, *catamenia*, or, in popular language, the "monthlies;" the function which has for its object the production of the flow being called menstruation. Popularly, when the function is normally performed, the female is *said to be regular* and at the period to be *unwell.*

The flow continues during the whole period of sexual activity in the female, save when she is pregnant or suckling her young. It commences in this country generally from the age of 13 to 15 years, and it ceases about 40 or 45. The period of its disappearance is often marked by various disturbances of the health of the individual, and hence is known as the *critical period*, *change of life*, etc. The first menstrual flow is generally preceded by feelings of languor, peculiar shooting pains in the thighs, backache, headache, chilliness, and various nervous symptoms, which, in many females, recur in a less degree at every return of the menses; but in others the *periods* are marked by no constitutional disturbance.

The flow normally returns every twenty-eight days, and continues from four days to a week, and the average discharge is about five ounces; but in many cases these limits are departed

from, the discharge occurring habitually, more or less often, and in greater or less quantities, without detriment to the individual.

Immediately before and during the flow there is more or less congestion of the whole genital system, with a soft relaxed condition of the vagina, and, according to Dr. Janser, a hypertrophied condition of the uterine follicles, all of which changes rapidly subside with the flow. In regard to the immediate cause of the discharge there is no doubt that it comes chiefly from the inner surface of the uterus, and it was formerly looked upon as a true secretion from the glandular mucous membrane lining that viscus, and this is even now held by some, but the prevalent view, at present, is that it is a true hemorrhage from the congested capillaries of the mucous membrane, the blood oozing from innumerable points, and being mixed with the acid mucus of the vagina, its coagulability is destroyed. According to Dr. Tyler Smith "the mucous membrane of the uterus is, in great part or entirely, broken up, and its *debris* discharged. The blood is probably exuded during the breaking up of the mucous structure, and the duration of the menstrual period represents the time occupied in this periodical decadence and renewal of the mucous membrane of the body of the uterus. A new membrane is formed every month. Blood corpuscles are abundant in the discharge, but it is deficient in fibrine."

That the ovaries exercise an important influence on menstruation is proved by the facts: 1. When they are absent congenitally, or from any causes, or disorganized, menstruation does not take place. 2. The period of active life of the ovaries commences and ceases with the flow. 3. When the ovaries are normal, the menstrual *molimen* recurs regularly, even if the uterus be absent. There have been various theories in regard to the flow. One is that the immediate cause of menstruation is the maturation and escape of an ovule from the ovary. According to this view every twenty-eight days a Graafian vesicle rises to the surface of the ovary and ruptures, during which process it gives rise to a peculiar erethism of the uterus and thus produces the discharge. The researches of Dalton and others have proven that maturation of the ovule and menstruation are very often consentaneous. But many females have conceived without menstruating, and impregnation may occur either during, just before, or after the flow, or even at any period between two successive returns of it. The theory named is therefore not yet established. Perhaps the following propositions of Mr. Kester represent the most probable view of the nature of menstruation.

1. Menstruation is a periodical function of the uterus.
2. Ovulation is the constant function of the ovaries.
3. Ova are discharged at all periods of female life in the intervals of, as well as at the time of menstruation.
4. Ovulation and menstruation being often concurrent, indicate that they are both the result of the attainment of a certain point in the development of the female economy.
5. The law of periodicity in the one not obtaining in the other, leaves still wanting the inseparable link in the chain of causa-

tion whereby menstruation can be shown to be the effect of ovulation.

6. At the menstrual period the ovaries become the seat of increased functional activity.

7. The menstrual flow is a true hemorrhage.

CHAPTER IV.

DISEASES OF MENSTRUATION.

Amenorrhœa.

SUPPRESSION of the menses may occur as an acute affection, *i. e.*, a sudden suppression of the discharge during the menstrual flow, or as a chronic complaint, *i. e.*, the habitual non-appearance of the menses. The former is commonly caused by sudden emotion, as fright, nervous shock, and exposure to cold or wet, occurring during the flow. It is generally attended by severe pain and other dysmenorrhœic symptoms, or by various hysterical manifestations—even convulsions. The measures calculated to relieve this are, rest in bed, hot hip-baths, mustard poultices, as revulsives, opium suppositories or enemata, hot ptisans, etc.

Habitual amenorrhœa may result from the acute form; more generally, however, it is dependent upon or intimately associated with anæmia, either spontaneous or occurring as the result of chronic disease, such as phthisis, etc. Plethora sometimes produces it, and also certain obscure abnormal conditions of the ovaries. Vicarious hemorrhages from the lungs, stomach, etc., are especially frequent in plethoric, but sometimes happen in anæmic amenorrhœa.

The principal object of treatment is to remove the cause if possible. Thus, if plethora be present, as indicated by headache, increased by stooping, flushed face, full strong pulse, vigorous health, etc., it must be combated. Bleeding, general, or, better, local, by cups to the sacrum, or leeches to the cervix; saline purgatives, restricted diet, plentiful exercise are indicated: afterwards, if amenorrhœa prove obstinate, aloes may be employed. In anæmia, the opposite measures must be used, namely those appropriate to this condition, such as iron, and other tonics, strychnia, generous diet, rest, with exercise according to the strength. As to emmenagogues, aloes, cantharides, savin, black hellebore, myrrh, etc., may be employed; most of these act by stimulating the pelvic viscera, and thus, on the principle of contiguous sympathy, the uterus; and are contra-indicated by existent excitation or irritation of that organ. These remedies are to be employed between the menstrual periods; at the periods, they may be supplemented by hot hip-baths, hot diaphoretic stimulating drinks, Dover's powder, breast poultices, etc. *Galvanism*

is lauded by some practitioners ; it is applied along the spine, or, perhaps more effectually, so as to pass through the pelvis. The possibility of amenorrhœa being dependent upon commencing pregnancy should always be borne in mind.

In some cases, the menses fail to appear at the ordinary age in the young girl, constituting the affection known as *emansio mensium.* If the breasts be not developed, the hair of the pudendum not grown, nor the other signs of puberty present, the probabilities are that the case is simply one of delayed puberty. Even if this is not the case, there is no specific treatment. Apparent emansio mensium sometimes is only retention of the menses from imperforate hymen, etc. The diagnosis depends upon the existence of the signs of puberty, the regular recurrence of the menstrual nisus, the enlargement of the abdomen, with the physical signs discoverable upon vaginal examination. The remedy is incising the hymen.

Menorrhagia.

Excessive menstruation may consist either in the too frequent recurrence, too long continuance, or too rapid flow of the discharge ; frequently these are associated. Causes, over-excitement of the genital organs, hemorrhagic diathesis, over-fatigue, especially on the feet, particularly when associated with anæmia and general relaxation of the system. Uterine hemorrhage in the unimpregnated female is often produced by some organic disease, such as uterine ulceration, simple or cancerous, and polypi or fibroid tumors. In menorrhagia the patient is almost always anæmic and relaxed. To relieve this, rest, good diet, iron, and astringents are indicated. Tincture of the chloride and the ammonio-ferric alum are the best preparations of iron, uniting astringency to their tonic properties. During the flow gallic acid may be administered in large doses. Fluid extract of ergot, in teaspoonful doses, is perhaps the most reliable anti-hemorrhagic in these cases. Oil of savin is sometimes very effective when there is great uterine relaxation. The patient must be kept quiet on her back during the paroxysm. In some instances various local measures are required, such as applying cloths wrung out of ice-water to the abdomen or pudendum, and the use of cold astringent injections, such as infusion of oak bark. Plugging with a tampon is rarely requisite, save in hemorrhage dependent upon organic disease. When polypi exist they must be removed. When there is severe hemorrhage, especially with cancerous ulcerations, the application, to the ulcer or bleeding surface, of liquor ferri subsulphatis (Monsel's solution), either pure or diluted, may become necessary.

Metrorrhagia is uterine hemorrhage occurring between the menstrual periods. Its treatment, as above indicated, must be in accordance with its causation.

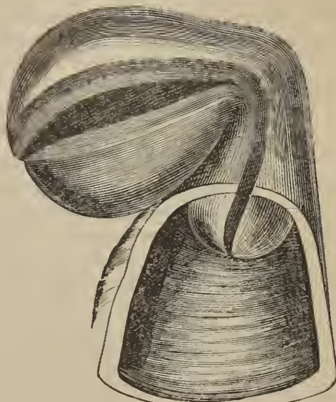
Dysmenorrhœa.

Painful menstruation seems to be constitutional with some women. It may be considered under two heads, *functional* and

mechanical dysmenorrhœa. The former of these is by some authors subdivided as *neuralgic*, *congestive*, and *inflammatory*; the latter, into *obstructive* and *membranous* dysmenorrhœa.

The SYMPTOMS are weariness, feelings of illness, pains in the back, perhaps headache, preceding the period; during menstruation the pains are often very severe, sometimes shooting down the thighs, sometimes simulating those of labor; the discharge is mostly scanty, sometimes accompanied by shreds of membrane or coagula. If the dysmenorrhœa be simply functional, the treatment between the periods resolves itself into the hygienic and medicinal measures best calculated to build up the health of the individual.

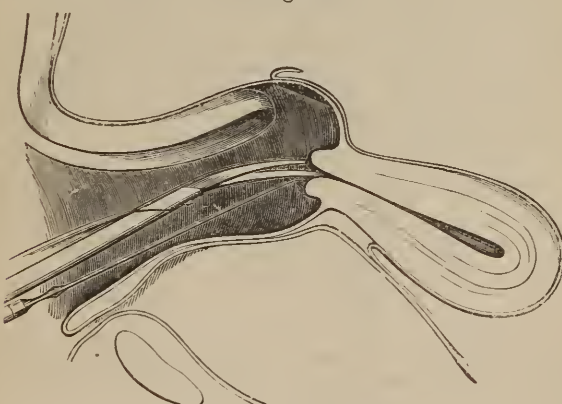
Fig. 416.



FLEXION PRODUCTIVE OF DYSMENORRHŒA.

During the paroxysm, rest in bed; cloths wrung out of hot water, renewed as they cool; anodynes, especially opiate suppositories, or enemata; camphor, bromide of potassium, hot ptisans, etc., should be employed; in some cases it is necessary to cup over the loins.

Fig. 417.



CERVICAL HYSTEROTOMY.

Mechanical dysmenorrhœa, which is dependent upon physical obstruction, presents similar symptoms. The diagnosis is to be

made out by physical examination. The ordinary cause of obstruction in the *cervix* is flexion in some of its varieties; constriction at the internal or external os is not infrequent. Mechanical measures are used to remedy these, pessaries for flexion, sponge-tents or cones of sea-tangle (*laminaria digitata*) are used to dilate the os. Some incise the neck by means of an instrument, the *hysterotome.*

Leucorrhœa.

This is an excessive and altered secretion of the mucus furnished by the membrane lining the vagina and uterus, by the follicles of the cervical canal, and the lacunæ of the vestibulum; generally white or nearly colorless and transparent, sometimes yellow or green, or slightly sanguineous and of varying degrees of consistency (Ashwell). The discharge in cervical leucorrhœa is generally scanty, resembling soft soap, more or less jelly-like, often with a curdled look, sometimes bloody; in some cases the discharge instead of presenting these characters is profuse and serous. In vaginal leucorrhœa the discharge is generally of a creamy consistence, yellowish, greenish, or brownish and very profuse.

Acute vaginal leucorrhœa is accompanied by a sense of weight, heat, and soreness in the vagina, tenderness, irritation of the bladder, pain in the lower belly and thighs, etc. The discharge, at first thin and acid, becomes whitish, or yellowish, and more consistent. The occurrence of the discharge generally relieves the urgent symptoms.

The *causes* of leucorrhœa are numerous. Prof. T. G. Thomas thus states them. *By congestion:* disordered menstruation; fibroids or polypi; prolonged lactation; rectal irritation; vesical irritation; gestation; parturition; excessive coition; anæmia. *By inflammation:* endometritis (inflammation of the interior lining of the uterus), corporeal or cervical; granular degeneration; ulceration; fibroids or polypi; gonorrhœa; inversion of the uterus.

TREATMENT.—If the patient be plethoric, moderate bleeding way be practised, either general or local; fomentations, rest, spare diet, and vaginal injections should also be used.

Chronic vaginal leucorrhœa is one of the most frequent diseases during menstrual life; sometimes, however, it precedes the menses. By most writers it is considered as a local disorder, inflammatory in its nature. It is frequently caused by cold, excessive coition, parturition, pessaries, displacements, and irritating food. There is seldom any pain accompanying it. If the discharge be great, weakness and pain in the back and loins may ensue.

The TREATMENT consists in the use of depletory measures if required; the removal of pessaries; tonics if the patient be weak; opium if pain be present; the administration of astringents, such as ammonio-ferric alum, of ergot, of various turpentines, etc.; and the use of astringent injections.

Uterine leucorrhœa, which is also often accompanied by constitutional symptoms, requires the use of local depletory measures at times, with the use of astringent injections, and tonics if the health

be feeble, particularly the preparations of iron. The solid nitrate of silver applied by means of a speculum to the interior of the cervix uteri has succeeded when other means have failed. Should there be any suspicion of a syphilitic taint, the remedies proper in such cases should be used.

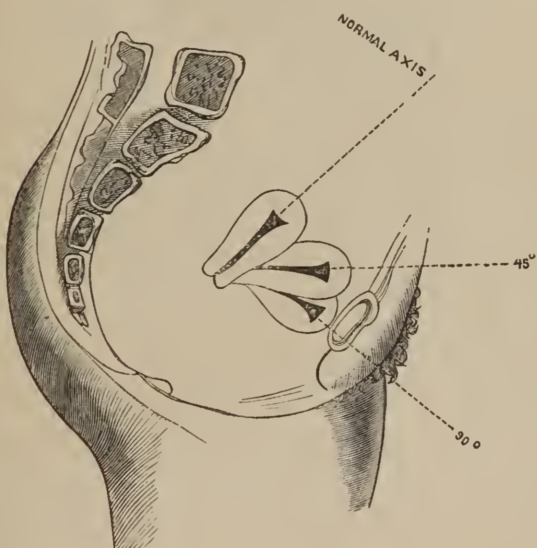
CHAPTER V.

DISPLACEMENTS OF THE UTERUS.

Displacements of the uterus may be arranged under four heads, viz.: Prolapsus, Anteversion, Retroversion, and Procidentia Uteri.

Prolapsus uteri is simple descent of the organ, the axis of which remains nearly parallel to the axis of superior strait, the neck pressing firmly upon the bottom of the pelvis, while the fundus points neither to the pubis nor to the sacrum.

Fig. 418.



The Degrees of Anteversion.

Anteversion is the falling forward of the fundus to such a degree that it presses against the bladder or pubis, while the os uteri points towards the lower or middle portion of the sacrum.

Retroversion is the turning back of the fundus into the concavity of the sacrum. It may be partial or complete, according as the fundus points to the upper, middle, or lower portion of the sacrum.

The neck of the uterus is often bent, so that we have prolapsus with flexion or simple flexion, anteversion with flexion, or *anteflexion*, and retroversion with flexion, or *retroflexion*.

Procidentia uteri is the projection of the organ out of the orifice of the vagina. It is *partial* when only a portion of the uterus protrudes, and conplete when the whole organ is exterior to the pudendum.

CAUSES.—These are predisposing and exciting. Among the former is relaxation of the broad and round ligaments, of the "reflected pelvic fascia," and of the vagina and perineum. Increased size and weight of the uterus, and tumor of this organ and of the ovaries, also predispose to displacements. Among the exciting causes are, too early rising after parturition, straining efforts in micturition and defecation, long and fatiguing walks, lifting heavy weights, carrying burdens, tight lacing, etc.

SYMPTOMS.—The local symptoms are sensations of fulness, pressure, and weight at the lower parts of the pelvis, often referable to the rectum, but more especially to the urethra, producing a frequent desire to micturate, also a difficulty in standing or walking, a feeling as if the pelvic viscera were about to escape, and pain in the "small of the back," extending to the groin and down the limbs.

The *general symptoms* have reference chiefly to the nervous system. The patient experiences a sense of languor, lassitude and "weakness." She often loses all interest in the ordinary affairs of life, and becomes peevish, irritable, and excitable.

The physician, however, must not expect to find invariably present all the symptoms named. There may, indeed, be decided displacement without any of these symptoms, and on the other hand the symptoms may exist without any displacement.

The DIAGNOSIS, therefore, must, in all cases, by made out by a careful vaginal examination.

In *prolapsus uteri*, the os will be found firmly impinging upon the posterior wall of the vagina, and upon the rectum. If the case be chronic, the anterior lip usually projects and is somewhat tumid, while the posterior is flattened.

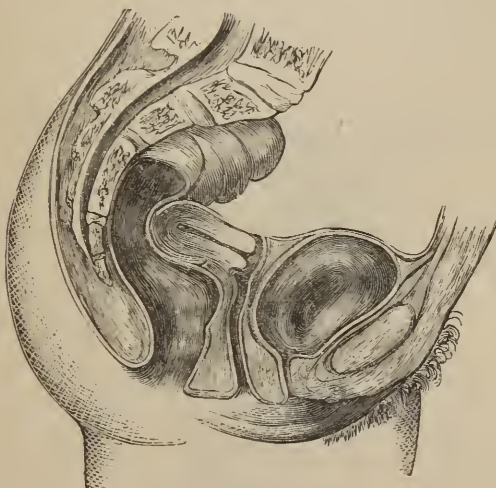
In *anteversion*, the fundus will be felt hehind the pubis, and the os in the hollow of the sacrum, far from the os coccygis.

In *retroversion*, when complete, the finger will detect a tumor through the upper portion of the vagina, resting upon the rectum. If the finger be pressed in front, against the bladder, it will find no firm resistance; but if it be passed into the rectum, a distinct tumor of the size of the uterus will be felt through the walls. If the diagnosis be not clear, it may be completed by using Simpson's womb sound, which should be passed into the uterus with its convexity turned to the arch of the pelvis. The index finger being introduced into the rectum, the point of the sound can be felt through the walls of the uterus and bowel. Impacted feces

in the rectum, and various tumors, have been mistaken for a retroverted uterus.

If *flexion* of the neck of the womb be discovered, the *position of the fundus* will determine whether it be a case of anteflexion, retroflexion, or simple flexion.

Fig. 419.



RETROVERSION OF THE UTERUS.

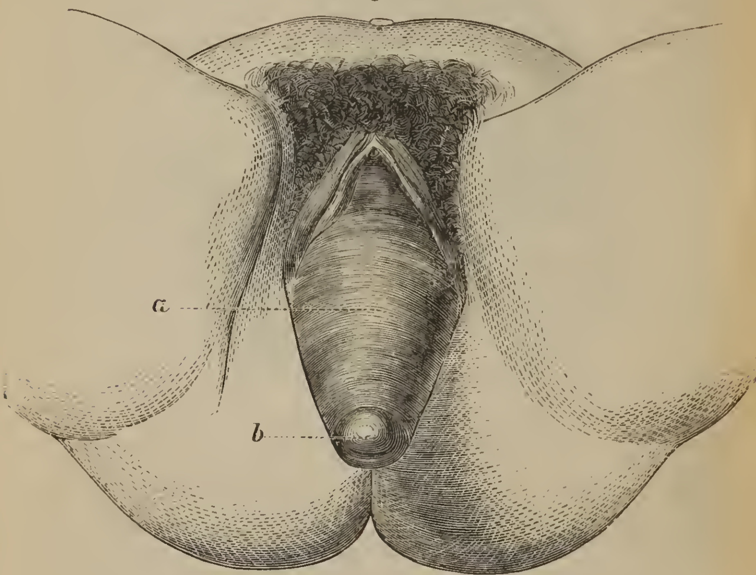
TREATMENT.—All exciting or predisposing causes should, as far as possible, be avoided or removed. The general health of the patient should be improved by proper medical and hygienic measures. The special treatment is, to replace the uterus *in situ naturali*, and maintain it there by suitable mechanical appliances. In prolapsus, anteversion, and procidentia, the womb may be readily raised by the finger or hand to its normal position. In retroversion the restoration is often more difficult, sometimes requiring the use of the uterine sound, which, being introduced as in diagnosis of retroversion, is slowly and carefully turned on its axis so as to bring its convexity to correspond to the concavity of the sacrum. The uterus, unless prevented by adhesions, will then have been restored to its proper position; but as this is often a painful operation, it is better, perhaps, gradually to bring the organ into place by means of proper pessaries, presently to be described.

The sound should not be used if pregnancy be suspected; but, the bladder and rectum being evacuated, and the woman placed on her knees and elbows, or, preferably, upon one shoulder and the opposite hand, the os should be pulled down with one index finger, while the fundus should be pushed up with the other, in-

troduced either into the vagina or rectum. Bond's instrument for elevating the retroverted uterus may be used with great advantage.

In *prolapsus uteri*, Dr. Hodge recommends the use of the "curved ring or lever." He says: "It accommodates itself to the natural curves of the vagina, allows mobility, and makes no pressure on the rectum or bladder, while it supports the uterus and takes away all pressure from its cervix."

Fig. 420.



EXTREME PROLAPSUS (PROCIDENTIA).

"In *anteversion*," he remarks, "almost any variety of pessary may answer, such as the spherical, the cervical, the cylindrical, the flat oval, the flat disk, the flat ring, the double or plano-convex, etc.;" but, "in ante-*flexion*, a *ring* pessary is all-important, as it alone supports the uterus at the base of the neck."

In *retroversion* the same author speaks highly of the "open lever, or U pessary," but states that "perhaps for the general practitioner, the closed lever, or S pessary may be more safe."

In *retroflexion* of the uterus all the usual pessaries fail, to a greater or less extent, in maintaining the fundus in situ. The intra-uterine stem pessary offers, theoretically, the greatest advantages in this form of displacement; but its use has been attended by such serious results that it cannot be recommended as a safe and proper instrument.

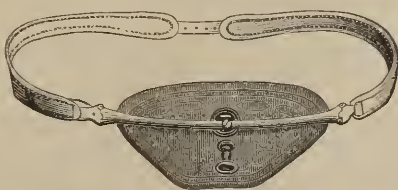
In procidentia uteri the great relaxation of the vagina and peri-

neum generally demands especial attention. The ordinary pessaries, unless of a very large size, are soon forced out of the vagina; if large enough to be retained, they excite inflammation by their pressure, and have to be removed.

A hollow ring pessary, made of soft rubber, and having a long flexible tube attached, with which it can be inflated to any desired size, has been successfully used in this form of displacement. It can be inserted by the patient, worn through the day, and at night removed and cleansed. Rings made of gutta-percha, or of vulcanized rubber, are now frequently used. Their elasticity is an advantage.

When pessaries cause discomfort they should be immediately removed. If they do not bring a sense of relief, they will be likely to do harm. The vagina should, daily, during their use, be freely syringed with castile soap and water.

Fig. 421.



Abdominal Supporter, with Pad.

The perineal pad, abdominal bandage, and the so-called uterine supporters have their advocates, and may, under favorable circumstances, be worthy of trial. Undoubtedly, in a certain number of cases, general relaxation of the abdominal muscles produces symptoms like those of uterine prolapsus; and, when this is the case, *external abdominal support* often gives relief.

CHAPTER VI.

IRRITABLE UTERUS.

Consists of a permanent and painful sensibility of the organ, especially of its neck; often accompanied by increased frequency of pulse, a dry, hot skin, and generally, in protracted cases, with gastric and renal derangement. This disease commonly occurs in the middle period of life, though it is sometimes met with in early youth.

The *local* symptoms are pain in the small of the back and sacrum, extending down the thigh to the knee, and around the brim of the pelvis to the lowest part of the abdomen. There are also some erratic pains in the thorax and loins. The character of the pain

is that of *soreness;* slight pressure relieves it, but it is aggravated by rough handling; sometimes it is spasmodic, like that of abortion.

The pain is aggravated by excitement of any kind, by exercise, and sometimes by standing. Straining, either in defecation or urination, constipation, flatulence, and diarrhœa will aggravate it.

A free vaginal examination may prove the uterus to be either displaced or engorged, but not altered in form, size, or density; extremely painful to the touch, in the body as well as in the neck.

CAUSES.—Among the predisposing causes may be placed, injudicious education, fashionable life, prolonged lactation, and temperament. Among the exciting, bodily exertion during menstruation, astringent injections, abortions, displacements, and sudden arrest of the menses from any cause.

DIAGNOSIS.—From neuralgic dysmenorrhœa, by the constancy of the pain. From acute inflammation of the cervix, by the absence of heat, swelling, and throbbing; by the absence of discharges, and by the slight change of the cervix compared with the amount of suffering.

PATHOLOGY.—Gooch considers it a permanently painful condition of the uterus, neither accompanied by nor tending to produce change in structure. Ashwell considers it a modified inflammation, or at least closely allied to inflammation or congestion. Thomas names it "areolar hyperplasia," on account of the increased formation of areolar or connective tissue commonly occurring in its course. This term omits, however, the recognition of the "irritability" which gave occasion for the name preferred for this affection by Hodge and others.

TREATMENT.—Two indications present themselves, viz.: 1. To mitigate local suffering; 2. To sustain and improve the general health. The first indication will be fulfilled by the use of anodynes, either by the mouth or rectum, or applied directly to the uterus itself; by the application of the nitrate of silver, and by anointing the cervix with anodyne unguents. The second indication, by rest, exercise in a recumbent posture, or, if it suits best, on foot or horseback; tonics, nutritious food, cold bath or the douche, and cheerful society. Scarifications of the neck of the uterus are highly recommended by some authors, especially if there be any congestion. The introduction of a pessary is often followed by marked relief, if there be any descent.

CHAPTER VII.

SURGICAL DISEASES OF WOMEN.

Diagnosis.

Rational signs or symptoms, and the past history of the patient, are never to be overlooked. Among the questions to be answered in the case of suspected uterine or ovarian disease, are these: Has the patient been married; if so, how long? Has she had children; how many? Did she ever miscarry? Is she, now, probably pregnant? If not, is menstruation regular in frequency, amount, and absence of suffering? Is there any vaginal discharge (leucorrhœa)? What are the symptoms of her present complaint, and what have been their duration and progress?

Physical Examination.

Better than a bed will be a table, covered with one or two blankets or a shawl, and a pillow. If a bed be used, its unevenness may be remedied by placing a board over the mattress and under the bedclothes. In either case, a sheet should be thrown over the patient to prevent unnecessary exposure of the person.

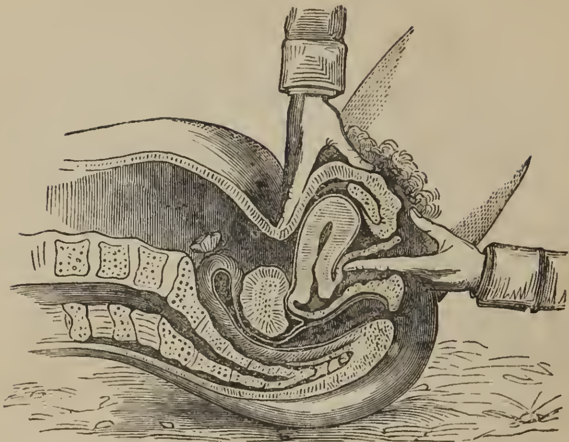
At first, the patient should lie on the back, with the knees drawn up; in a position affording a strong, direct light. For some methods of examination, the prone position, on the hands and knees, has decided advantages.

The modes of diagnosticating abdominal and pelvic affections in the female by physical examination are as follows:—

1. Vaginal touch.
2. Bimanual palpation.
3. Rectal touch.
4. Vesico-rectal exploration.
5. The speculum.
6. The uterine probe.
7. Dilating tents.
8. The endoscope.
9. The exploring needle.
10. Auscultation and percussion.
11. The microscope.
12. Anæsthesia.

Space is not allowed in this work to treat of many particulars concerning these methods. The student is referred, in regard to them, and for full information upon all the surgical diseases of women, to the treatises of Thomas, Sims, Simpson, Hewitt, Churchill, Hodge, Meigs, Bedford, Byford, Agnew, Atlee, and others, on the general subject or on the different departments of Gynæcology.

Fig. 422.



Bimanual Manipulation.

Besides the *vaginal touch*, *bimanual palpation*, and the *speculum* are the most important means available for the detection of uterine affections ; *e. g.*, displacements, ulcerations, tumors, etc.

The Speculum.

Cylindrical and *valvular* forms of the speculum are used. Both have their advantages and inconveniences. Some have two, others three or four valves or movable portions. They are employed not only for inspection of the uterus and vagina, but also for the ap-

Fig. 423.

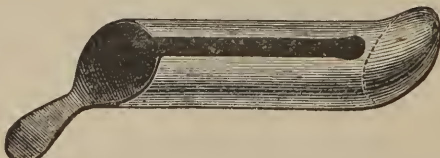
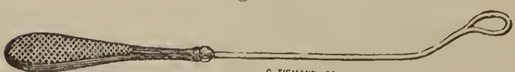


Fig. 424.



plication of probes, medicaments, etc. Sims's speculum is used with the aid of a depressor. Thomas has modified it so as to fix the depressor in connection with the blade.

Fig. 425.

The position of the patient preferred for the introduction of Sims's speculum is *semi-prone;* so as to allow the abdominal viscera to gravitate forward.

The Uterine Sound.

This is a firm rod of metal, of such a size and curve as to enter readily the uterine cavity. It requires skill and much care to use

Fig. 426.

SIMS'S PROBE, smallest size.

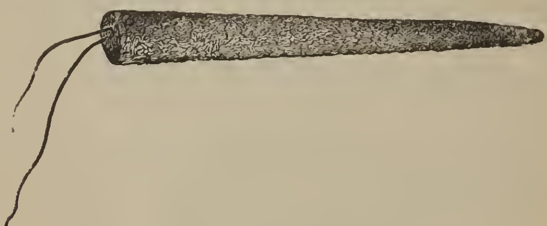
it safely. Very serious accidents are endangered by any over-violence with it. As stated by Thomas, the facts which may be determined by it are these :—

1. The capacity of the uterus.
2. The existence of growths within it.
3. Deviations of its canal.
4. Displacements, as discriminated from tumors.
5. The existence of endometritis.
6. The mobility of the uterus.

Dilating Tents.

These are commonly made either of sponge or of the *sea-tangle* (laminaria digitata). For the former a good clean sponge is cut into conical pieces from two to three and a half inches in length, and with bases varying from the width of the little finger to that of a walnut or an egg. Each piece may be dipped in a weak solution of carbolic acid or oil of cloves in glycerin; then saturated with mucilage of gum Arabic; a wire is next passed through its centre, and it is tightly wrapped from apex to base with strong cord. Then the wire is taken out and the sponge is allowed to dry. After that the cord is removed and another cord is passed through the sponge and sewed fast to its apex.

Fig. 427.



A Sponge Tent.

The advantage of the sea-tangle tent is that it affords no animal matter to decompose and produce fetor or irritation.

Dilatation of the uterus by tents is not free from danger. Tetanus and peritonitis have sometimes followed their employment. The tent ought never to be left in the uterus more than twelve or, at the longest, twenty-four hours; and the patient ought to remain in bed during that time and for one or two days afterwards.

The Endoscope.

This is a long slender tube, through which, with a strong light, any long narrow passage, as the urethra, may be inspected. It has little special value for vaginal or uterine examination.

Exploring Needles.

These, made hollow so as to have the function of a small trocar and canula, may be used with great advantage in ascertaining the character and contents of uterine, ovarian, and other pelvic and abdominal tumors, dropsical accumulations, etc. Dieulafoy's *aspirator* may be made use of also to withdraw fluids without a large

incision; or, in its place, the *hypodermic syringe* has been employed by Thomas and others.

Ulcers of the Uterus.

Much discussion has occurred as to the fitness of the application of the term *ulcer* to such "granular degenerations, erosions, or abrasions" as are observed about the *os* and *cervix* of the uterus. The term is, however, thus applied by most gynæcologists. Thomas describes six varieties of cervical ulcerations :—

1. Granular.
2. Follicular.
3. Inflammatory.
4. Syphilitic.
5. Corroding.
6. Cancerous.

Of these the *granular* ulceration of the vaginal (exterior) surface of the cervix is the most frequent. Its symptoms are sometimes slight, in other cases quite grave. It is produced by all causes of uterine irritation or inflammation; as *displaçements, sexual abuses; pressures; injuries during parturition.*

In a serious case, the symptoms may be as follows: *leucorrhœa*, sometimes bloody or purulent; *pain* and *bloody discharge after coition; menorrhagia; pain on locomotion;* constant *pain in the back and loins; general debility and hysterical disorder.*

Examination by means of the *vaginal touch* and the *speculum* will make certain the presence or absence of ulceration. "The cervix, more especially near the os, is seen to be covered by a mass of pus, which being removed lays bare an intensely red, granular, hemorrhagic-looking space of greater or less extent, closely resembling the inner surface of the eyelids when affected by granular degeneration. The diseased surface does not appear depressed below, but is sometimes even elevated above the surrounding mucous membrane." (Thomas.)

TREATMENT.—The ulcer of the uterine cervix is to be regarded as the sign and effect of a morbid condition of the uterus itself. *Endometritis* (inflammation of the lining membrane of the uterus) or *congestion* of the body or neck of the womb, may exist and require treatment. Or, a *displacement* may be causing continual irritation, by friction of the os or cervix against the floor of the pelvis.

For the ulcer itself, authorities advise the application of *caustics*, especially the solid nitrate of silver; and *astringents*, as the "styptic colloid" of Richardson. The latter is essentially a strong solution of tannic acid in collodion. The speculum is required for the effectual localization of the effect of caustic, which should not be used without care and observation of its effects. Once a week will generally be sufficient for the application.

Vaginal *suppositories* are sometimes employed; consisting of *tannin, oxide of zinc, alum, extract of belladonna*, or *opium*, made up with starch or gum, glycerin or cacao-butter, to the proper size and shape. Astringent *washes*, also, are serviceable; used once or twice every day, consisting of alum, sulphate of zinc, or tannin, with glycerin and tepid or warm water. A drachm of

sulphate of zinc, or two drachms of alum or tannin, with an ounce of glycerin and a gallon of water, will be strong enough.

For the description and treatment of other varieties of ulcer of the uterus, we must refer the student to special works on Gynæcology.

Uterine Tumors.

Morbid growths may occur on the *exterior* or *interior* surfaces of the uterus, or in the substance of its walls. A simple classification of them is into *fibroid* tumors (myo-fibromata), *fibro-cystic* tumors (cysto-fibromata), uterine *polypi*, and *cancers* of the uterus.

Fibroid tumors are the most frequent. Generally there is but one developed in the same uterus; commonly in the body or fundus. Occasionally several occur at a time, and attain a great size. The tissue of the tumor is firm and tough, creaking when cut. Microscopically, it consists of "long, fine fibres, generally united in bundles; of fusiform fibre-cells, analogous to fibro-plastic elements; and of round or elliptic granules of small size; the whole being bound together by fine intercellular substance." All of these are derived, by modification, from the normal tissues of the womb; chiefly the connective tissue, but in part the smooth muscular tissue also. The negro race is especially liable to fibroid tumors of the uterus. They occur most frequently between the ages of thirty and forty-five; especially in sterile women.

Symptoms.—These vary, on account of the *complications* and *secondary effects* of morbid enlargements or growths of the uterus.

There may be excessive menstrual flow (menorrhagia); intermediate hemorrhage (metrorrhagia); irritability of the bladder and lower bowels; pain in the pelvic region; uterine tenesmus, or bearing down pains; leucorrhœa; dysmenorrhœa; aud signs of pressure on the crural vessels and nerves.

Physical Signs.—These may require the use of *vaginal touch*, *bimanual palpation* through the vagina and abdominal walls, *recto-vaginal* palpation, and the *speculum;* sometimes, the dilatation of the os and cervix uteri with tents.

By such means we may discriminate between fibroid tumor of the uterus and anteflexion or retroflexion; ovarian tumors; fecal accumulation in the large intestine; pelvic hæmatocele (bloody tumor from hemorrhage within the pelvis); peri-uterine cellulitis (inflammation of the areolar or connective tissue around the uterus); and pelvic abscess.

Treatment.—Spontaneous cure of fibroid tumors sometimes occurs by *absorption*, *expulsion*, *sloughing*, or *calcareous degeneration*. Much more frequently, when they have obtained a moderate size, they remain stationary until the period of the cessation of the menses; after which they undergo slow atrophy. *Palliation* of their symptomatic effects is, in most cases, the only proper treatment. Sometimes life is threatened by irritation and exhaustion. Then an operation for the removal of the tumor is justified, if it appear practicable. This may also be proper when the enlargement is so situated as to be easily removed, without much injury to the parts involved.

The methods of treatment resorted to for the cure of uterine

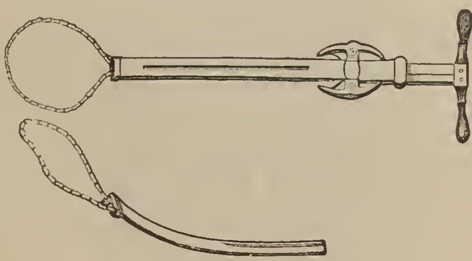
fibroid tumors are these: *absorption; excision; écrasement; enucleation; sloughing; incision; gastrotomy.*

Absorption has been attempted by the internal or hypodermic administration of medicines; as chlorate of potassium, iodine, iodide and bromide of potassium, ergotin, and several mineral waters. Although successful results have been asserted, the dependence of the recovery upon the medicinal agent used remains in doubt.

Excision, by means of a knife or scissors, may be practised when a small fibroid projects into the uterine cavity, so as to be within reach after dilatation of the cervix by tents.

Ecrasement, *i. e.*, cutting away at the base by the écraseur or chain-saw of Chassaignac, is to be preferred in certain cases to excision.

Fig. 428.



Braxton Hicks' *wire-rope* écraseur will sometimes answer still better for the same purpose. A very large tumor, filling the vagina, may be drawn down by obstetric forceps and extruded, so as to be cut away by the knife or écraseur; or it may, *in situ*, be cut away piece by piece to the base. It is only when the tumor is small and near the cervix that excision is suitable; and the use of the écraseur requires that the attachment should be smaller than the body of the tumor.

Enucleation is an operation including (after dilatation of the cervix by tents) the making of one or more incisions into the body of the tumor, and then, by introducing the finger or a blunt instrument, detaching it forcibly from its base. This is attended by considerable danger, especially of peritonitis and pyæmia. Dr. West reports a mortality of 14 cases out of 28 operated upon in this manner.

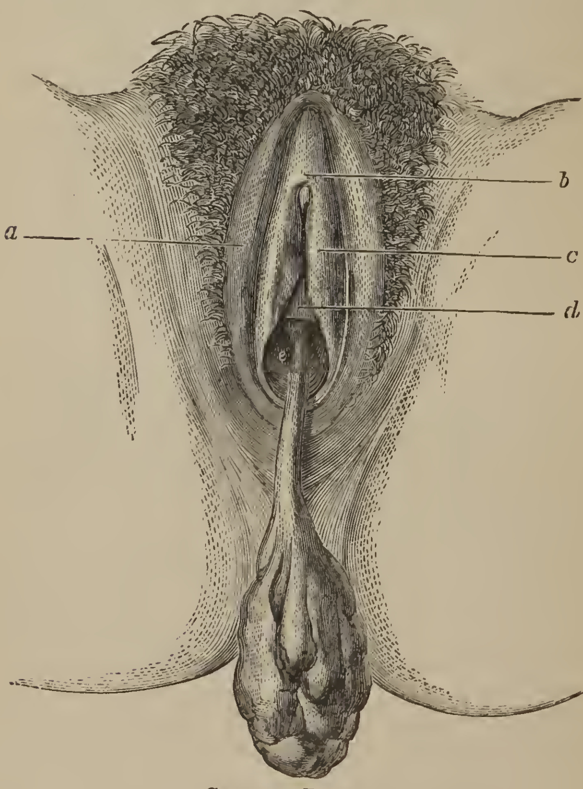
Sloughing has been sometimes artificially induced by "gouging" the tumor; *i. e.*, cutting a deep circular hole in it, and filling it with oiled lint. This is certainly a dangerous procedure, seldom justifiable in practice.

Incision is performed in some cases, where removal is not practicable; with the view of impeding the nutrition and growth of the tumor. A bistoury or scissors may be used; and the operation may be repeated several times. Although blood flows freely at the time, it often happens that the tendency to hemorrhage is

diminished by the change produced in the tumor. This is a much less violent and dangerous practice than gouging or enucleation.

Gastrotomy is the opening of the abdomen by the knife for the removal of a tumor. It is so serious an operation that few surgeons will undertake it for uterine fibroids. Extirpation of the uterus itself has been performed, with the result of 28 deaths in 35 cases. Gastrotomy for the excision of fibroid tumors from the uterus has met with about 1 success in 4 cases. The method of procedure is the same as in ovariotomy. Its perils are, 1, shock; 2, hemorrhage; 3, peritonitis; 4, septicæmia or pyæmia.

Fig. 429.



CELLULAR POLYPUS.

Fibro-cystic tumors are formed by the degeneration of solid tumors, so as to render their contents partly or wholly fluid. This may occur with malignant as well as benign formations. It is,

however, uncommon. The *diagnosis* of such tumors requires their discrimination from *pregnancy*, *ovarian cysts*, and from ordinary fibroids of the uterus. Their treatment should be conducted upon precisely the same principles as the latter.

Polypi are tumors covered by the mucous membrane of the womb, and attached to it by a stem or *pedicle*. Thomas mentions four kinds; *cellular*, *glandular*, *fibrous* and *fibrinous* polypi.

The *symptoms* attending uterine polypus are of two kinds; *irritative* to the uterus and thus disturbing to the general system, and *obstructive* to the process of menstruation. The health of the patient is gradually lowered, so that, without violent disturbance, life is apt to be shortened, through debility and anæmia.

Treatment.—Palliation of the symptoms is often possible; by appropriate support of the uterus by means of a pessary; keeping the patient in bed at the time of menstruation, to prevent excessive loss of blood, to which she is rendered liable by the presence of the polypus; strengthening the system by tonics and good diet, and by the avoidance of severe fatigue; and the introduction into the vagina at night (after syringing with tepid water), of a suppository of tannin and cacao butter; with the addition to it of one or two grains of opium when there is considerable pain.

Curative treatment requires a surgical operation; which is not to be resorted to in every case; having danger, even to life, attending it. An intra-uterine polypus, above the *os internum*, is the most serious to interfere with. *Vaginal* polypi may be very safely removed. The methods of operation are—

Excision,
Torsion,
Ligation,
Ecrasement,
Galvano cautery.

Excision is performed, according to circumstances, either with a knife, scissors, or curved "polyptome;" *torsion*, by seizing the tumor with forceps and twisting it off at the neck; *ligation* is tedious, and is now seldom resorted to; the *écraseur* and the *galvano-caustic* wire are preferred, for expedition and safety (in skilful hands) in some of the more difficult cases.

Cancer of the uterus presents a general resemblance to cancer of other organs. It is more frequent in the uterus than in any other part of the body. Its characteristic is malignancy; *i. e.*, tendency to indefinite growth, destructive changes, involvement of neighboring parts, constitutional depravation, and disposition to return after surgical removal. Some pathologists distinguish *epithelioma* or *cancroid* from *carcinoma* or true cancer; yet the former is not devoid of malignancy, though exhibiting it often in less positive degree. Carcinoma of the uterus is divisible into three kinds; *scirrhus*, *colloid*, and *encephaloid*. The *cervix* is the part of the uterus most often attacked. The *scirrhous* form or hard cancer is rare; the *colloid* or jelly-like form less so; the *encephaloid* or soft cancer the most frequent. The duration of cancer of the womb, from its beginning until death, varies from a few months to several years; average, rather less than two years.

It seldom occurs before middle life; the greatest number of cases being met with between 40 and 50 years of age.

SYMPTOMS.—These are as follows:—

Pain in the pelvic region;
Tenderness;
Menorrhagia;
Leucorrhœa, with offensive odor;
Dark, bloody, grumous discharge;
Progressive general debility;
Sallow, cachectic appearance.

Pain is not always severe; in a few cases it is absent.

PHYSICAL SIGNS.—By vaginal touch, the morbid character or destruction of the uterine tissue may be perceived. If a very small portion can be removed without much disturbance, it may be examined with the microscope. The characters of the discharge are always very important in the diagnosis. Care is needful to distinguish cancer from *papillary growth* upon the cervix uteri; *polypus; fibroid tumor; bleeding ulcer;* and *syphilitic ulcer.*

TREATMENT.—As stated by Prof. Thomas, the indications are—

To destroy or remove the cancer;
To check hemorrhage;
To relieve suffering;
To correct fetor;
To improve or support the general strength.

Amputation of the neck of the uterus is the only operation that affords much hope; and this only when, at an early stage of the disease, it can be made to include all of the cancerous formation. Caustics have been very often used, but without encouraging success, in any form but that of cancroid or *epithelioma.*

Palliative measures are to be resorted to upon general principles, according to the indications above mentioned. Pain will often require opiates, by the mouth, vagina, or rectum. Fetor may be corrected by the use of washes, containing dilute solutions of carbolic acid, chlorinated soda, permanganate of potassium, etc. All but the last named may be made with glycerin as well as with water. The constitutional strength should be supported by generous diet, milk, beef-tea, and, in appropriate cases, stimulants. (For *ovarian tumors*, see Chapter XXVI.)

CHAPTER VIII.

OVULATION.

THE Graafian vesicles are little sacs in which the ovules are formed. They are to be seen in the ovary at birth in an undeveloped condition; but at puberty they commence to ripen, find their way to the surface of the ovary, and discharge their ovules; and this process is constantly repeated until the sexual life of the

female ceases. The mature follicle has two coats—an external vascular one, consisting of condensed ovarian stroma—and an inner fibrous one, lined with epithelium. At first, the minute microscopic speck—the ovule—is in the centre of the follicle, which at this time contains semitransparent albuminous matter and granules, the latter accumulated in a layer on its inner surface, forming the so-called *membrana granulosa.* Immediately surrounding the ovule is another mass of granules, the so-called *tunica granulosa;* and connecting these two are bands of granules, the so-called *retinacula.* When the Graafian vesicle rises to the surface of the ovary, these bands contracting draw the ovule and surrounding granules to the membrana granulosa, and the three (mem. granulosa, tunica gran., and retinacula) fuse together, so that the ovule becomes imbedded in a mass of granules, the so-called *proligerous disk.* The ovule, about $\frac{1}{200}$ of an inch in diameter, is composed of an external membrane, *zona pellucida*, or *vitellary membrane; vitellus*, or *yelk*, and a peculiar cell, the germinal vesicle. Of these, the function of the first is simply to inclose the others—that of the second, to act as a storehouse of food—whilst the last is the part which, when impregnated, is developed at the expense of the second, and forms the embryo. It is about $\frac{1}{720}$ of an inch in diameter, and contains a well-marked nucleus, the *macula germinativa*, or germinal spot. The bursting of the Graafian follicles, and consequent discharge of the ovule, is produced by a rapid accumulation of liquid in the follicle and consequent stretching, and, at last, rupture of the coats of the ovary. At this time the fimbriated end of the Fallopian tube is closely applied to the ovary, and a free passage is afforded the ovule to the uterus, whence if not impregnated it either passes out or is decomposed. The little cicatrices seen on the ovaries are the results of this process. After rupture, certain changes take place in the Graafian vesicles, which, when impregnation follows, are very marked and give rise to the *corpus luteum.* Directly after the rupture a hemorrhage into the sac takes place, resulting in the formation of a clot. At the same time the outer highly elastic coat contracts, and as it were folds up the inelastic membrane, which then gives the appearance of irregular radii from the central clot; at the same time the membrane is enlarged and undergoes a peculiar change, which gives it a yellow hue. The existence of a corpus luteum is not a certain sign of pregnancy, but simply of ovulation. Certain changes in it are, however, indications of pregnancy. According to Dalton, in the virgin, the corpus luteum rapidly disappears, and in three weeks is rarely to be found. In pregnant women the size of the corpus luteum increases for about forty days, when it is nearly an inch in its longest diameter, and five-eighths of an inch in its shortest. It now remains stationary till near the end of the third month, when it commences to lessen, and by the end of the fifth month it is scarcely more than half the size; by the end of pregnancy it is very small, but can sometimes be detected several months after labor. (On Generation and Development, see PHYSIOLOGY.)

CHAPTER IX.

PREGNANCY.

Signs.

THESE are of two kinds, *rational* and *sensible*. The rational are those which are rather symptoms than signs in the strict sense, any of which may be produced by other causes than pregnancy; they are of importance more especially in the earlier months of gestation.

In the absence of certain positive signs, the diagnosis must always be made with caution. This is especially the case in the first two or three months, when the practitioner should be very chary of a positive opinion.

The important *rational signs* are as follows: *Cessation of the menses.* This usually but by no means always happens in the earliest stages of gestation; on the other hand, women are occasionally regular through the whole period, and the menses frequently cease from other causes.

Morning Sickness.—Nausea, with occasional or even constant vomiting; this begins generally at the end of the first month, continues from six to eight weeks; in some women it occurs only on first rising, but in others it is more or less constant throughout the twenty-four hours; sometimes it commences immediately after conception, and it may continue through the whole nine months. It is a nervous phenomenon, mostly unaccompanied by furred tongue or other signs of gastric irritation, but the result of the close sympathy between the uterus and stomach. It is very rarely altogether absent.

Kyestein.—This is a peculiar substance formed in the urine of pregnant females, which was formerly believed to be a proof of pregnancy, but is now known to occur occasionally at other times and even in the urine of men; at the same time its presence or absence is a strong indication of the woman's condition.

In order to ascertain whether it be present, expose the urine in a tall bell-glass for two or three days, at a temperature of 70° F., when if it be present the urine will become turbid; in two or three days more a pellicle will have collected on the surface, and this will increase in firmness for about two weeks; the odor of kyestein is thought by some to resemble that of tainted beef, by others to be cheesy.

Quickening is the name given to the peculiar sensations caused by the first perceptible motions of the child in the uterus. It is variously described as a fluttering, a sinking sensation, etc., by different mothers, and would be a very reliable sign were not other

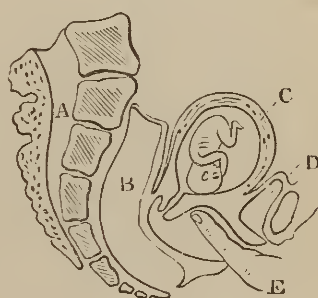
feelings frequently mistaken for it, as, for instance, the movements of flatus in the intestines, spasmodic twitchings of the abdominal muscles, etc.

The *sensible signs* are : *The enlargement of the abdomen.* In the first months of pregnancy, the abdomen is rendered rather flatter than normal, but after this it gradually enlarges until the middle of the ninth month, when it lessens somewhat.

Ballottement.—In order to perform this, place the patient either in the standing or semi-recumbent position, steady the uterus with the left hand applied to the fundus, and having introduced the index finger into the vagina, give a short, quick, sharp upward movement to the cervix uteri, when a sensation, as though something had receded and fallen back on the finger, will be felt. The cause of this is simply the minute fœtus, which, lying in a large amount of water, is thrown from the cervical end of the uterus toward the fundus and back. This test is most available during the fifth and sixth months; afterwards the increased size of the child prevents it.

Pulsation of the Fœtal Heart.—By auscultating the abdomen of a female sufficiently advanced in pregnancy, two sounds may be heard, the so-called *bruit de souffle*, and the rapid sound of the fœtal heart. The former is made by the placental circulation, and probably has its immediate origin in the large venous sinuses; it is a sort of prolonged, muffled sound, resembling that heard in the large veins of the neck of a chlorotic patient, and is synchronous with the pulse of the mother. The other resembles somewhat the ticking of a watch, and is repeated about one hundred and twenty-five times a minute. It is first discoverable between the fourth and fifth months, and sometimes, owing to excess of the liquor amnii, position of the child, and various other obscure causes, cannot be heard until much later. It often happens that it may be discoverable at one examination and not at the next, re-appearing perhaps at the following one. It is the *only absolutely certain sign of pregnancy*, and is often valuable as proof that the fœtus is alive. It is most generally to be heard to the left, between the symphysis pubis and scrobiculus cordis, whilst the uterine souffle may be in most cases detected low down on the sides of the abdomen after the fourth month.

Fig. 430.



A. Sacrum. B. Rectum. C. Uterus and ovum. D. Bladder. E. Finger in position for ballottement.

Changes in the Mammæ.—These are often important signs. During the first month there is often, but not always, irritation and enlargement of these glands. During the second month the

nipple and the parts around it become more prominent, at the same time the areola loses its pink color and becomes brownish, whilst the sebaceous glands scattered through it become very much enlarged.

A table exhibiting the signs of pregnancy at various periods.

FIRST AND SECOND MONTHS.

RATIONAL SIGNS.	SENSIBLE SIGNS.
1. Suppression of the menses (numerous exceptions). 2. Nausea—vomiting. 3. Slight flatness of the hypogastric region. 4. Depression of the umbilical ring. 5. Tumefaction of the breasts, accompanied with sensations of pricking and tenderness.	1. Augmentation in the size and weight of the uterus. 2. Descent of the organ. 3. The womb is less movable. 4. Its walls have the consistence of caoutchouc. 5. The neck is directed downwards, forwards, and to the left. 6. The orifice of the os tincæ is rounded in the primiparæ, but more patulous in others who have had children. 7. A slight softening in the mucous membrane covering the lips, and this membrane appears œdematous.

THIRD AND FOURTH MONTHS.

1. Suppression of the menses (a few exceptions). 2. Frequently, the appearance or the continuance of vomiting. 3. A small protuberance in the hypogastric region. 4. Less depression of umbilical cicatrix. 5. Augmented swelling of the breasts, prominence of the nipple, and slight discoloration in the areola. 6. Kyestein in the urine.	1. The fundus uteri rises to the level of the superior strait towards the end of the third month, and is perceived at the close of the fourth about the middle of the space between the umbilicus and pubis. 2. A perceptible flatness on percussion in the hypogastric region. 3. A rounded tumor as large as a child's head of a year old, may be detected by the abdominal palpation. 4. By resorting to this process and the vaginal touch jointly, the displacement en masse, and the volume of the uterus may easily be ascertained. 5. The neck has the same situation and direction during the third month as in the preceding ones; at the fourth it is elevated and directed backwards and to the left side. 6. The softening of the periphery of the orifice is much better marked. The latter is more open in *multiparæ*, even admitting the extremity of the finger; but is closed and always rounded in primiparæ.

FIFTH AND SIXTH MONTHS.

RATIONAL SIGNS.

1. Suppression of the menses (some rare exceptions).
2. The disturbance of the digestive orgaus generally disappears.
3. Cousiderable development of the whole sub-umbilical region.
4. A convex, fluctuating, rounded abdominal tumor, salient, particularly on the middle line, and sometimes exhibiting the fœtal irregularities.
5. The umbilical depression is almost completely effaced.
6. The discoloration in the areola is deeper, glandiform tubercles; areola spotted.
7. Kyesteiu in the urine.

SENSIBLE SIGNS.

1. The fundus uteri is one finger's breadth below the umbilicus at the end of the fifth month, and the same distance above it at the expiration of the sixth.
2. Fœtal irregularities and active movements, which are very perceptible.
3. The sound of the heart and abdominal souffle are now perceptible.
4. Ballottement.
5. A tumor is felt at the anterior superior part of the vagina, which is sometimes soft and fluctuating, at others rounded, hard, and resisting.
6. The inferior half of the intravaginal portion of the cervix uteri is softened.
7. The whole ungual part of the first phalangeal bone can penetrate the cavity in the neck in *multiparæ*. The latter is softened to the same extent iu primiparæ, but the orifice is closed.

SEVENTH AND EIGHTH MONTHS.

1. Suppression of the menses (the exceptions are very rare).
2. Disorders of the stomach (rather rare).
3. The abdominal tumor has the same characters, except that it is more voluminous.
4. A complete effacement of the umbilical depression, the dilatation of the ring, and sometimes a pouting of the navel.
5. Numerous discolorations on the skin of the abdomen.
6. Sometimes a varicose and œdematous condition of the vulva and inferior extremities.
7. Vaginal granulations—abundant leucorrhœal discharge (often absent).
8. Deeper discoloration of the central areola and an extension of the spotted areola. Sometimes there are numerous stains on the breasts; flow of milk; complete development of the glandiform tubercles.
9. Persistence of kyestein in the urine.

1. Increased size of the abdomen.
2. The fundus uteri is four fingers' breadth above the umbilicus at the seventh month, and five or six at the eighth.
3. The organ is nearly always inclined to the right.
4. More violent active movements of the fœtus.
5. Sounds of the heart and abdominal souffle.
6. Ballottement is very evident during the seventh month, but more obscure in the eighth.
7. The softening extends along the neck above the vaginal inscrtion. In primiparæ the cervix is oval, and seems to have diminished in length, in others it is conoidal, the base being below and sufficiently patulous to admit all of the first phalanx. The neck at its superior fourth is still hard and shut up.

FIRST FORTNIGHT OF THE NINTH MONTH.

RATIONAL SIGNS.

1. The vomiting frequently reappears.
2. The abdominal tumor has increased; the skin is much stretched, and very tense.
3. Difficulty of respiration.
4. All the other symptoms persist, and are increased in intensity.

SENSIBLE SIGNS.

1. The fundus uteri reaches the epigastric region and gains the border of the false ribs on the right side.
2. Active movements, sounds of the heart, and abdominal souffle.
3. Often there is no proper ballottement, but merely a kind of rising of the tumor formed by the head.
4. The neck is softened throughout its whole length, excepting the circumference of the internal orifice, which still remains closed and resisting. In women who have previously borne children, the finger may be introduced into the cervix to the extent of a phalanx and a half, and in fact is only arrested by the internal orifice, which is closed and wrinkled, though in some cases already beginning to open. In primiparæ the softening is equally extensive, and the neck is swollen in the middle in an ovoidal form: but the external orifice, although partly opened, does not permit the introduction of the finger.

LAST FORTNIGHT OF THE NINTH MONTH.

RATIONAL SIGNS.

1. Vomiting often ceases.
2. The abdomen is fallen.
3. The respiration less oppressed.
4. More difficulty in walking.
5. Frequent and ineffectual desires to urinate.
6. Hemorrhoids; augmentation of œdema and varicose state of the lower extremities.
7. Pains in the loins, and colics.

SENSIBLE SIGNS.

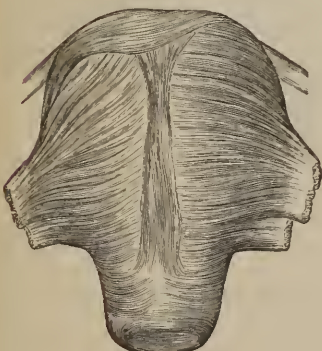
1. The fundus uteri has sunk lower than in the first fortnight.
2. Active movements; bruits du cœur and de souffle.
3. Ballottement often imperceptible.
4. The head more or less engaged in the excavation.
5. In *multiparæ* the internal orifice softens and dilates; the finger can penetrate through a cylinder, as it were, an inch and a half in length, and come into contact with the naked membranes. In *primiparæ* the internal orifice experiences the same modification, but the external remains closed. During the last week, in consequence of the spreading out at the internal orifice, the whole cavity of the neck becomes confounded with that of the body, and the finger in reaching the membranes only traverses a thin orifice in primiparæ, but a rounded collar in the others, of a variable thickness.

Uterine Changes connected with Pregnancy.

As has been before stated, the chief bulk of the impregnated uterus is made up of fusiform embryonic nucleated cells about $\frac{1}{4000}$ of an inch in diameter, their length being a little greater. Immediately following fecundation they elongate, so that by the end of the ninth month they are from seven to eleven times as long, and by two to five times as broad; not only so but a vast number of new fibre-cells are formed during the first six months of gestation, and also undergo development. To these fibre-cells the uterus owes its muscular power.

The muscular character of this organ, at full time, is exhibited by the following plates:—

Fig. 431.



External Layer of Muscular Fibres.

Fig. 432.

Internal Layer of Muscular Fibres.

Immediately after labor the muscular fibres begin to undergo fatty degeneration and rapid atrophy. The whole tissue is softened, and the cells themselves become excessively friable, and are thickly studded with oil drops. They finally undergo absorption and entirely disappear. During this process a new series of nucleated cells appear, similar to the embryonic fibre cells of the virgin. These new cells appear, according to Kölliker, in about three weeks after parturition, but the whole process occupies several months. When from any cause it is not properly effected, menorrhagia and various uterine disturbances result. When the new cells are not sufficiently formed, the uterus is said to become atrophied, and amenorrhœa and sterility result.

The bloodvessels also are rapidly developed. The uterine and ovarian arteries are enlarged to several times their usual size, while the corresponding veins are augmented perhaps even to a greater degree.

According to Dr. Lee, during pregnancy the nerves of the

uterus undergo a great increase in size and development. This has been variously upheld and denied by numerous observers, and the question is still unsettled, although medical opinion seems to incline to the view that no such development takes place.

Fig. 433.

BLOODVESSELS OF THE PREGNANT UTERUS.

The duration of pregnancy is nine calendar or ten lunar months, or more accurately two hundred and eighty days. The French law fixes the extreme limit at three hundred days, and it is generally allowed that a protraction of four weeks is possible. On the other hand, there is no doubt that some women habitually fall short of the usual time, and indeed some of the older authorities fix the normal term at two hundred and seventy-three days. The Earl of Spencer and M. Tessier found that out of five hundred and seventy-seven cows no less than twenty calved beyond the two hundred and ninety-eighth day, whilst some went till the three hundred and twenty-first, the regular period of gestation in the cow being two hundred and eighty days. The ordinary method of computation is to add two hundred and eighty days to the date of the disappearance of the menses.

Extra-Uterine Pregnancy.

From very imperfectly known causes it sometimes happens that the impregnated ovum fails to enter the uterus, and is more or less perfectly developed elsewhere. This misplaced gestation is known as *Extra-Uterine Pregnancy*, or *Exfœtation*. All the varieties of it may be classed under four heads: 1. Tubular fœtation, when the arrest takes place in the Fallopian tube. 2. Interstitial fœtation, when the ovum becomes enveloped in the walls of the uterus. 3. Ventral or abdominal pregnancy, when the ovum falls into the abdominal cavity, and there finds a nidus. 4. Ovarian fœtation, when it remains in the ovary. Of these, the first is the most common, the second the rarest.

The SYMPTOMS of this condition are simply the various symptoms and signs of pregnancy, with the absence of the peculiar changes in the uterus, perceptible on tactile examination, together with the presence of a tumor in various localities as the case may be. The fœtus frequently becomes encysted, and may thus remain in a dormant condition for many years. An instance is on record of a woman having borne seven live children whilst carrying an extra-uterine fœtus. In most cases the cyst finally either ruptures causing death from hemorrhage or shock, or else it forms adhesions and ulcerates, so that the remains of the putrescent fœtus are discharged through fistulous orifices, it may be, directly through the abdominal integument, or through the bowels, vagina, bladder, etc. In such cases the patient occasionally recovers, but more generally dies of exhaustion through the protracted suppuration excited.

The TREATMENT in these cases is, of course, merely palliative; the symptoms must be closely watched and their indications fulfilled, the main remedial measure being the upholding of the patient's strength in all possible ways.

CHAPTER X.

PREMATURE EXPULSION OF THE FŒTUS.

THE uterus may expel its contents at any time during the nine months of pregnancy, but is more apt to do so in the first three than during the succeeding six months. It is also more apt to do so at the time when the menses would have occurred if conception had not taken place.[1] During the first three months the connections between the fœtus and the mother are more slight than afterwards, and at the returns of the menstrual periods there are more or less excitement and congestion of the ovaries and uterus; hence the two facts just noticed. When the expulsion occurs previously to the sixth month, it constitutes *abortion*, afterwards *premature labor;* before the sixth month the child necessarily perishes; it is not *viable.*

According to Mr. Whitehead, on an average, about a little more than one pregnancy in seven fails to continue until the full time. The causes may be studied under the head of maternal and fœtal.

Maternal.—One of the most common of the maternal causes, is disease of the neck of the uterus, with its attendant leucorrhœa. This disease may be simple or syphilitic inflammation and ulceration, granular os, induration of the cervix, etc. Acute diseases of the mother are frequent causes of abortion, sometimes acting directly, but perhaps in the greater number of cases indirectly, by

[1] A *mole* is a product of conception in which the embryo has been blighted, but development of the membranes continues for a time.

causing the death of the fœtus. Constitutional syphilis frequently produces miscarriage in the latter way. Accidents, such as falls, blows, and all forms of external violence; mental emotions, such as sudden joy, anger, grief, etc.; intense pain, luxurious habits, or those of the opposite extreme; weakness, whether constitutional or arising from debilitating discharges or other transient causes; over-fatigue, administration of ergot, savin, and various other drugs, are occasional causes of miscarriage. It is said that women may acquire a *habit* of aborting: thus Dr. Schultze reports the case of a lady who miscarried twenty-two times, at about the same period of gestation.

Fœtal.—Anything which causes the death of the fœtus of necessity produces its discharge. Disease of the placenta, especially fatty degeneration, or of the membranes or funis, imperfect attachment of the placenta, various diseases of the mother, etc., act in this way.

SYMPTOMS.—There are generally preliminary symptoms, such as feelings of languor, a sense of uneasiness and weariness, achings in the back, sometimes pains resembling those of menstruation; after these have continued a greater or less time, symptoms similar to those of labor come on. Either before or at this period a hemorrhagic discharge from the vagina appears, sometimes preceded by a mucous discharge. If the woman be far advanced, the case will closely resemble one of labor at the full time. If the fœtus be very young, there are but few manifest and peculiar symptoms, except it be that of flooding. At the end of the first or even second month, abortion may readily be mistaken for menorrhagic menstruation. The flooding may be very profuse, but it is very rarely fatal if properly treated; it is always to be feared so long as the shell of the ovum remains in the uterus.

TREATMENT.—The first indication is to *avert* the abortion if possible, in order to save the child, unless the latter be evidently dead. Very rarely are we able to decide whether the child is dead, and hence the rule always to act as though it were living. If there has been marked hemorrhage, the chances of averting it are poor; but if there has been no discharge, although the pains be severe, they are good. The second indication is, if the miscarriage will go on, to shorten it and prevent hemorrhage.

PREVENTIVE TREATMENT.—The woman should be on a hard mattress, in a cool room and lightly covered; she must be kept perfectly quiet in body and mind, all excitement, stimulants, or any cause of irritation being sedulously removed. If she be plethoric, it may be proper to bleed moderately; *opium* must be administered freely so as to quiet the uterus if possible. If there be any hemorrhage, it should be combated by the application of cold to the vulva, and the exhibition of sulphuric acid or other astringents.

If the attempt to arrest the miscarriage fails, the second indication remains to be carried out. The important point is the hemorrhage; if this be slight and the pains active, there is little to be done. When there is much flooding the best means of restraint is the *tampon*, at least during the earlier months of pregnancy. For the mode of application see the article on hemorrhage

complicating labor. It must be borne in mind that the tampon causes the expulsion of the ovum, and is therefore not to be used so long as there is a chance of saving the pregnancy. Enemata of ice-water may be tried. Ergot may be exhibited in full doses. If these measures fail to cause the discharge of the ovum, an attempt may be made to pull it out of the uterus with the finger, the hand being introduced into the vagina; or if it cannot be reached in this way, a small blunt wire hook may be employed, as advised by Dewees. Great care should be taken not to wound the uterus. A much safer instrument than the wire is Bond's placental forceps.

Fig. 434.

Bond's Placental Forceps.

In those cases in which there exists a habit of aborting, the woman should be carefully watched during her pregnancy; her system should be kept by judicious measures in as healthy a condition as possible, neither plethoric nor anæmic, and when she approaches the period of gestation at which abortion habitually occurs she must be kept perfectly quiet, free from all bodily or mental excitement, reclining on her couch or lounge, and if it seems advisable, constantly under the influence of opium. The habit has been broken up in some inveterate cases by a protracted separation of the woman from her husband, *i. e.*, by resting the uterus.

Pathology of the Fœtus.

The fœtus is liable to many of those diseases that attack the child after its birth. Many of these are entirely independent of the mother, but there are also many with which it is seriously affected through her. As examples of the latter may be classed those cases of premature expulsion which occur during the prevalence of epidemic diseases, and where the fœtus appears to have participated in the disease of the mother. Examples are not wanting of cases where children have been born with smallpox or measles, and children born of mothers laboring under intermittent have exhibited the same disease after birth.

There is scarcely an internal organ that has not been described as the seat of inflammation; the brain and its membranes, the lungs and pleura, the peritoneum, the mucous membranes of the lungs and bowels, may all be the seat of inflammation during intra-uterine life.

In addition to these acute diseases, the fœtus presents even more numerous cases of chronic affections; general hypertrophy or atrophy, syphilitic diseases, calculus, dropsy, jaundice, hernia, etc. Even the bones and the joints may be the seat of disease;

children are sometimes born with rickets, caries, and necrosis; and it has happened to many practitioners to meet with cases of fracture of some standing in children just born. Unfortunately we possess neither the means of diagnosticating nor of treating these cases of intra-uterine disease.

The signs of the death of the fœtus are also obscure and uncertain. Absence of the sound of the fœtal heart is a negative sign, and its value will depend much upon the skill of the auscultator. If after repeated and careful auscultation of the abdomen no trace of fœtal pulsation can be detected, the death of the fœtus may be asserted on safe grounds. *Cessation of the movements* of the fœtus is no proof of its death, as the movements may be suspended for some days without its occurrence. The sensation of a weight in the abdomen rolling about as the woman moves, is, with some rare exceptions, a sure sign. The subsidence of the abdominal tumor, flaccidity of the breast, after having been tense, and the general deterioration of the health, are all enumerated among the probable signs. The concurrence of all these renders the diagnosis nearly certain, though separately they are of little value.

The SIGNS during labor are much more accessible and certain. The loose, flabby scalp, the absence of swelling, occasionally emphysema of the cellular tissue beneath, the looseness and grating of the cranial bones, and the sharpness of their edges, are enumerated by Dr. Rigby among the certain signs. The absence of pulsation at the great fontanelles is admitted to be an important sign.

In *presentations of the face*, the lips of a dead child will be flaccid, and the tongue flabby and motionless, and the presenting part slightly swelled. The contrary in a living child.

In *breech presentations*, the sphincter ani in a dead child is relaxed and insensible to the finger. In a living child it is closed and resists the finger. The presence of meconium is a sign of no value.

In *arm presentations*, when the child is dead, the limb is cold, livid, and flabby; there is no pulsation at the wrist (the latter is not of much value, as pressure may arrest it), and the epidermis soon begins to peel off. In a living child, the arm will swell and become livid.

In *prolapsion of the funis*, the presence or absence of pulsation will decide. There are exceptions to this rule, however, as in the case related by Dr. Kennedy, in which the cord was prolapsed an hour, and during a pain no pulsation was perceptible; but when the pain subsided he drew the funis backwards towards the sacro-iliac symphysis, and then detected a faint pulsation. The child was delivered by the forceps.

Fetid *liquor amnii* is not a certain sign of the child's death, neither is the presence of meconium in it, especially in the breech cases.

CHAPTER XI.

LABOR.

Labor is the term applied to the process by which the contents of the gravid uterus are expelled. Normally in the human female it occurs about two hundred and eighty days from the date of conception.

The uterus is the principal agent in effecting this process, aided, it is true, in the latter stages, by the abdominal muscles and diaphragm.

The action of the uterus is simply that of the contraction of its muscular parietes. This contraction is entirely involuntary, and in a great degree intermittent. It is often accompanied with severe suffering, from which it receives the popular name—*a pain.*

Each contraction of the uterus tends to diminish its size, produce propulsion, and finally expulsion of its contents. The fœtus is entirely passive during the whole process. The contraction goes on after the birth of the child, extrudes the placenta, and prevents hemorrhage by closing up the orifices of the bleeding vessels.

The immediate causes of labor are not well settled. According to Dr. Simpson and others, it is the perfection and maturity of the fœtus. He says the loosening and decadence of the membranes and placenta from the interior of the uterus constitute the cause of parturition, and that this loosening or decadence is itself the result of the effete degeneration of the decidua towards the full term of pregnancy. On the other hand, Dr. Tyler Smith believes that the ovaries excite uterine contractions. He found that irritation of these bodies would excite premature labor in a pregnant rabbit, and says: "The ovaries acting at or near the tenth month from the time of the ovulation, which has ended in impregnation, excite in the uterus those changes which lead to the expulsion of the ovum." The general features of labor are the same in all cases, but the details differ greatly. It is always attended by suffering if the patient be conscious, but some suffer vastly more than others, even without obvious cause. The duration of uncomplicated labor varies very much, not only in different women, but in the same woman in different pregnancies. It very rarely occupies less than an hour, or, when uncomplicated, more than two days. It is as a rule more tedious in first labors, owing probably to relaxation not taking place as readily as at other times.

Various classifications of labors have been proposed by different authorities, but the simplest and most useful is into *natural labors* or *eutocia*, and *preternatural labors* or *dystocia;* the former including

all those in which the woman is competent to deliver herself without external assistance, and the latter those in which manual or instrumental aid is required. Some authorities limit the term natural labors to head-presentations.

Natural Labor.

SYMPTOMS OF LABOR.—These are best discussed under two heads: 1. Premonitory symptoms. 2. Those which appear after labor has commenced.

The most important of the precursory symptoms are: Subsidence of the abdominal tumor; mucous discharge from the vagina; relaxation and distensibility of the latter, and of the external organs; and more or less irritability and restlessness on the part of the patient.

The diminution of the abdominal tumor is caused in part by the sinking of the gravid uterus into the cavity of the pelvis, and in part by the "painless contractions" of the uterus.

It is to be regarded as a favorable symptom, as showing a good-sized pelvis. The mucous discharge and relaxation of the parts indicate a disposition in the passages to yield as the labor progresses.

The SYMPTOMS showing the commencement of labor are a glairy, often bloody, mucous discharge from the vagina, known in the lying-in room as the "show," irritability of the bladder and rectum, nausea and vomiting, rigors or shivers, and peculiar intermittent pains.

Labor actually divides itself into three stages, and as the symptoms of each are peculiar, they will be best described under the several heads. The first stage is that of dilatation, and terminates with the commencement of the second, that of expulsion, which ends with the birth of the child, whilst during the third stage the after-birth is excluded.

First Stage.—This is generally the longest and most worrying of all. The patient is exceedingly uneasy, restless, anxious, desponding, complaining, constantly moving from the bed to the chair, then to the *pot de chambre*, which she has a constant desire to use, and thus is continually unsatisfied. The cries which the pains give rise to are peculiar, rather high pitched but not loud, whining, moaning, and accompanied with impatient gestures or those of great distress; indeed, the character of the cry is so peculiar as to be diagnostic; once heard it will always afterwards be recognized. The nausea and vomiting are often distressing, but are thought to hasten the dilatation. The pains are generally referred chiefly to the upper part of the vagina and back; they are sharp and cutting, or rending and tearing, and are supposed to be caused by the stretching open of the cervix uteri. The nurses call them *grinders*.

By placing the hand upon the abdomen during a pain, the uterus can be felt to contract and harden itself, and at the same time tilt forwards so as to bring its axis into accordance with that of the superior strait. As the pain goes off, the uterus becomes soft again, without, however, returning to its former state of relaxation. The approach of a pain may often be foretold by the practitioner

before its access, by auscultation. The moment a pain begins, and before the patient is herself aware of it, we hear a short rushing sound, which appears to proceed from the liquor amnii, and to be partly produced by the movement of the child, which seems to anticipate the coming on of the contraction; nearly at the same moment all the tones of the uterine pulsations become stronger; other tones which have not been heard before, and which are of a piping, resonant character, now become audible, and seem to vibrate through the stethoscope like the sound of a string which has been struck and drawn tighter while in the act of vibrating. As the pain grows stronger the pitch rises. By the time the pain has reached its height the sound has entirely ceased, or become very faint; as it departs, however, the sound again returns as at the beginning of the pain; and finally attains its former tone, which it had during pregnancy. The noise made by the escape of the blood through the uterine veins during a contraction, is probably an important element in production of the sound in question. The pulse increases in rapidity in proportion as the pain rises in intensity, subsiding in the same manner with it. As the labor advances the rapidity of the pulse increases, so that shortly before the child is born it has attained the maximum that it had during the height of the pains in the commencement. The phenomena which have been described are repeated during every succeeding pain (the intervals being shorter and the pains longer) until the dilatation of the os uteri is completed. During the whole period of the first stage the pains have been acting, not so much for the expulsion of the child, as for preparing the passages for that purpose. The more completely the os uteri is opposite to the fundus, and the greater the correspondence between the axis of the uterus and that of the superior strait, the more speedily will the dilatation be accomplished. As soon as this has taken place the first stage is ended. The obstetrician should make an "*examination*" during the first stage, the object being to learn whether labor actually has commenced or not, and the prospect for a tedious or rapid parturition. It is also sometimes possible to recognize the presentation during the first stage, and under some circumstances this is very important to be done. If the vagina be found dry, except in the very outset, it indicates a so-called dry labor, and is of course unfavorable; it should be relaxed, soft, and bathed with mucus. The os should be found low down in the pelvis; when high up it may be looked on as pointing somewhat towards a slow labor. The conditions of the os itself may be arranged under four heads. First, it is thick, moist, soft, and dilatable, feeling much like wet chamois leather. Second, it is thin, soft, cool, moist, feeling somewhat like a piece of wet brown paper. Either of these is favorable, and points with great certainty to a rapid first stage. Again, it may be thick, hard, and dry, perhaps painful, imparting the sensation almost of cartilage to the finger, or it may be thin, hard, dry and sensitive, feeling like whip cord. Both of these states are unfavorable, indicating, especially the last, a rigid os and very slow dilatation. In primiparous women the dilatation is generally tedious and painful. As the circle of the os dilates there can be felt during a pain a tense,

elastic, convex protrusion, the so-called *bag of waters;* the membrane containing a portion of the liquor amnii alternately becoming tense and relaxed as the pains come and go. This is thought to aid mechanically in the dilatation of the os, acting as a sort of wedge which forces it open. It is important to preserve it intact until the dilatation is complete, as it protects the child from over-compression. When the membrane gives way there is a rush of fluid, and the bag of waters is said to be broken.

Second Stage.—The phenomena now manifested are essentially different from those just described. Expulsion has taken the place of dilatation. The contractions of the uterus are much more powerful, and are now aided very much by the abdominal and respiratory muscles. The pains are longer and more frequent and the suffering greater; during them the glottis is shut down, and the respiratory muscles become rigid, in order to afford a fulcrum, as it were, for the straining abdominal muscles to work against. There being thus no possibility of the latter forcing the contents of the abdominal cavity upwards, their whole force is expended downwards, acting directly upon the fœtus. To these peculiar forcing pains the name of "bearing down pains" is given. The straining is in a measure involuntary, but is also very much under the control of the patient. The cries which these pains cause are very different from those of the first stage; they are a sort of straining, expulsive grunt, sometimes ending in a short scream as the pain goes off, especially when the child's head is pressing upon the perineum. As the pain approaches, the woman seizes hold of anything within reach, and brings the muscles of the extremities, abdomen, chest, and back, to aid her expulsive efforts. The whole actions resemble on a much larger scale, those of straining at stool in persons of costive habits.

If the membranes have not previously ruptured they almost always give way during one of the earlier pains of this stage. Indeed some authorities date the commencement of the second stage from their rupture.

The presenting part of the child descends more or less at every return of the contractions, but as the pain goes off it again recedes, not, however, to the point it occupied before, as there is generally more or less advance on that gained by the preceding effort. If it were not for this gradual advance and recession there would be great danger of laceration of the soft parts, from a continued expulsive effort, before the passages were sufficiently dilated to receive the presenting parts. It thus not only takes away the danger of pressure, but is in itself a good sign, inasmuch as it proves that the cavity of the pelvis is sufficiently capacious. The woman during the second stage is much less irritable than in the first. She seems to have recovered her energy and equanimity, and, if this stage be prolonged, will often sleep between the pains. The young practitioner should be on his guard, however, in relation to this drowsiness, particularly if it occurs in primiparæ, and be much protracted, or accompanied with headache, as it may be indicative of congestion.

During the descent of the presenting part, especially if it be the head, the pressure which it exerts on the sacral nerves frequently

gives rise to severe cramps in the lower extremities. Having passed through the brim and cavity, the head now arrives at the floor of the pelvis and commences to distend the soft parts at the inferior strait. At each return of the pains the perineum is distended more and more, each time only partially recovering itself between them, until at last a bulging tumor appears between the thighs ; at the same time the rectum has been flattened, its contents driven out, and its lower end often slightly everted. The alternate advance and retrocession go on until at last the perineum becomes scarcely thicker than paper. Here again appear the advantages of this intermittent action of the uterus. In case of steady pressure the perineum would probably be torn, if the force was sufficiently violent to produce speedy expulsion ; or sloughing would be endangered, if it were too long continued. Finally the scalp of the child can be perceived in the distended vulva, all the soft parts are now stretched to their utmost ; the anus projects ; the whole perineum is very much elongated ; the labia majora undergo great distension, and the crisis is at hand. The pains now redouble their intensity, and finally a tremendous, prolonged pain overcomes all resistance, and accompanied by a cry of anguish from the mother, the child's head suddenly enters the world.

Fig. 435.

Head at the Outlet.

There is now generally an interval of rest for several minutes, at the expiration of which feeble pains come and the child is born without further trouble.

The third stage of labor includes the detachment and expulsion

of the placenta. In some cases this takes place simultaneously with that of the child, but generally there is an interval between the two. The length of this interval varies; the average is about twenty minutes; very frequently it is much shorter, and sometimes is even as great as an hour. If it be more than the latter period in any case, in all probability there is some morbid attachment of the placenta. When the interval, whatever its length may be, has elapsed, the uterus again contracts, but not nearly so powerfully as before, the after-birth is detached, forced out of the womb and finally extruded from the vagina by the contraction of that canal, its expulsion being generally accompanied with a gush of blood or clots. The bag of membranes is mostly turned inside out, especially if the after-birth has been extracted by pulling on the cord.

CHAPTER XII.

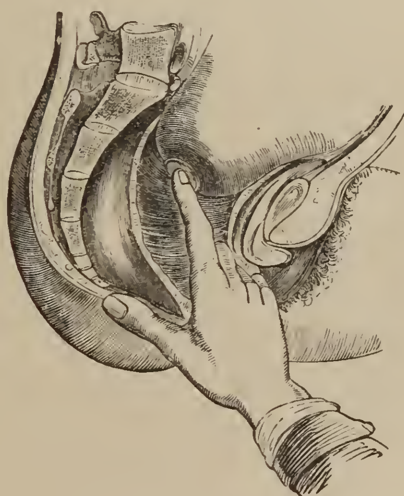
MANAGEMENT OF NATURAL LABOR.

The first precept in regard to the management of natural labor is to avoid "meddlesome interference." There is in truth very little for the obstetrician to do in such cases save normally to sustain the mother, and to exercise throughout a gentle patience. The surgical appliances needed are few, perhaps a catheter and nothing more. It is a valuable precaution to carry a small phial of ergot (fl. extract) and one of laudanum. A piece of muslin or strong toweling suitable for a binder is generally prepared by the nurse, also strong pins, fine twine, tape, or, better, patent thread to tie the cord with, and a pair of blunt pointed scissors to cut the same. The practitioner should see, during the first stage, that these are ready and handy, to avoid confusion at the crisis; also that the bed is properly made. The bed should be prepared by covering the mattress with a piece of oil-cloth, and upon this should be placed, at the position of the patient's hips, several folds of old blankets or comfortables, which will absorb the various discharges of water, blood, mucus, etc., and can be removed after the labor is completed without disturbing the patient; the sheet on which she is to lie, being so folded up as not to come down lower than her shoulders, is thus kept dry until wanted, when it can be drawn down. Attention should also be given to the arrangement of the patient's dress. Her chemise and night-robe should be so folded up as to prevent their becoming soiled, the lower part of her person being temporarily protected by an old skirt which can readily be removed at the proper time, and her other clothing brought down; the object being to avoid changing the woman's dress while in the weak condition immediately succeeding labor.

There is, as stated, but little to be done in a case of natural labor; but it would be wrong to assume that any particular case was such, and the first duties are to ascertain the *state* of the mother, the *presentation*, and if possible the position of the child, and to foresee

as far as may be the general features of the coming labor. The medical history of the mother during pregnancy, and in multiparæ that of past labors, often afford data to prognosticate probable accidents and to take measures accordingly. Thus, a history of post-partum hemorrhage in her past accouchements would cause the careful obstetrician to administer a full dose of ergot just before the birth of the head. There is no use in delaying vaginal examination, it should be made immediately; if satisfactory, it need not be repeated until the second stage, unless some peculiar circumstances should call for it. The mode of making it is as follows: the patient should lie upon the bed on her left side, with her hips near to the edge of the bed and her knees drawn up towards her abdomen. The fore-finger of the right hand (sometimes two fingers, and occasionally the left hand) well greased should be passed from the anus forward, thus entering the vulva from behind (Fig. 436), then it is to be directed upwards and backwards

Fig. 436.



VAGINAL EXAMINATION.

towards the promontory of the sacrum, until the os uteri or presenting part be encountered. The absence of deformities, sufficiency of pelvic room, heat and moisture of the vagina, effects of a pain, condition of the os and cervix uteri, of the bag of waters and the presenting part, are the chief points to be noted. An experienced physician will often detect the last even before the rupture of the bag of waters, and after that event, not only the presentation but also position ought to be made out. The finger is commonly introduced during a pain, but the parts must be studied

both during and between the contractions. The prognosis is to be made up by the consideration of the frequency and force of the pains with the work to be done, but should be given with reserve, as it may often prove to be a mistaken one. During the first stage the presence of the accoucheur in the room is scarcely desirable, and the woman may be allowed to be up and in whatever position she may prefer. The patient during this stage may be allowed food of a simple character in moderate quantities. Various hot drinks are thought to hasten the pains, and are sometimes useful, but no stimulant, as a rule, should be given. The bowels should be thoroughly emptied by enemata and a care should be exercised that the urine is freely passed. The patient should also be cautioned against making any voluntary bearing down efforts during dilatation as they exhaust her and do not aid in the least. When the second stage comes on, the woman should be put to bed, whilst the physician should now stay in the room. Various positions are preferred in different countries, probably the best is that in vogue in this country as well as in England. The woman is placed on her left side near the bottom of the bed, with the knees drawn up, her body bent forward, her feet resting against some portion of the bedstead, and her hands grasping a sheet firmly fastened to the latter. If the labor prove tedious, she may be allowed from time to time to change her position.

If the membranes have not broken spontaneously, it is often advisable now to rupture them, which may be done by scratching them with the nail during a pain, or, if very tough, a probe may be used. When the head reaches the floor of the pelvis, the accoucheur should take his seat beside the bed, in order to be ready to support the perineum as soon as it becomes necessary, *i. e.*, when it becomes distended and protruding. The object is twofold: first, to afford a moderate counterpoise to the pressure from within, and thus to prevent disastrous effects from any sudden severe pains; secondly, to prolong, as it were, the curves of the sacrum, and thus cause the head to be carried forwards through the vulva, instead of being forced through the perineum. To do this the left hand may be applied along or across the perineum, from the coccyx to the anterior edge. The amount of pressure needed is but little; it should be more firm posteriorly than anteriorly. When the head is almost emerging, the skin must be drawn forwards over it, so as to lessen the chance of laceration. The right hand should receive the head, allowing it to rotate and carrying it forwards as the shoulders are driven, not pulled out, the left still guarding the perineum. If a twist of the cord around the neck of the child exist, it should be disentangled, to prevent interference with the circulation in the cord. The objections urged by some against supporting the perineum are not valid.

As soon as the child is born the physician should lay his hand upon the abdomen of the mother, when the contracted uterus should be felt as a large, roundish, moderately hard tumor; if it be not so, but be imperceptible, or feel like a soft doughy mass, friction must be made over it to induce contractions, either by the accoucheur, or, if the child require his attention, by the nurse. The patient may now be allowed to rest a few minutes if there be no

flooding, after which when the uterus contracts, gentle traction should be made on the cord to ascertain whether the placenta be detached. If so, it may be removed by continuing the traction, which should be made by introducing the index finger of the right hand along the cord, and hooking the placenta downwards and backwards in the direction of the axis of the superior strait, afterwards in the direction of that of the sacrum, pressure being made at the same time on the uterus; if the cord do not yield, the after-birth is not detached as yet, and no force should be used. A little patience, with occasional frictions to the uterus, will be all that is necessary. After the placenta is removed, the binder should be applied from the ensiform cartilage to the great trochanters; if there be any tendency to uterine relaxation it is well to place a sort of compress of folded napkins beneath the binder, so as to increase the pressure on the uterus. A napkin should be laid over the pudendum to absorb the discharges.

Duties during the Puerperal State.

After the woman and child have been made as comfortable as possible, the physician should assure himself that the binder is properly adjusted, and that the uterus is still firmly contracted, before leaving the house. He should order the patient to be kept in a nearly horizontal position, and completely quiet, no talking or bustling being allowed in the room, which should be temporarily darkened, and well ventilated, and from which every one except the immediate attendants and husband must be excluded. If she be nervous, restless, and somewhat exhausted, small doses of morphia with or without camphor may be administered, and any irritation of the pudendum may be relieved by occasional washing of the parts with warm milk and water. Frequently, lying-in women are troubled with peculiar uterine pains, similar to, but less severe than those of labor. These are the so-called *after-pains*, which are often neuralgic, and best relieved by opium and camphor conjoined; but at other times they are true contractions, due to the presence of clots in the womb, which that viscus is endeavoring to expel, and which should, as far as possible, be carefully removed with the finger. The physician should see his patient again in about eight hours, at the longest within twenty-four, when he must inquire if she has passed her urine since the birth; if she has not and cannot, he must draw it off for her; it must not be allowed to accumulate in the bladder. He must ascertain whether the child has passed urine or feces, and, if not, should see that there is no malformation. The child may be put to the breast during the first few hours, but should not be kept there much of the time. If the milk be long delayed it is sometimes necessary to feed the babe with a little milk and water. The *lochia* or cleansings are the discharges from the vagina which follow labor, and may be looked on as a mixture of blood and various secretions. For the first three or four days they are bloody, after that serous or purulent. Their duration varies greatly, and no special attention is necessary, excepting proper measures for cleanliness, and the remembrance that *changes* in them often mark *uterine* disease; normally they should be first reddish, then greenish, then yellow-

ish, then like dirty water; their odor is very peculiar, but not fetid. In case the discharge becomes offensive, vaginal injections of a solution of permanganate of potassium, glycerin, or other disinfectant will be advantageous. In certain cases, especially after severe labor, the patient suffers greatly from *nervous shock*. There is great exhaustion, with a suffering, anxious, oppressed countenance, rapid, small, fluttering pulse, and often morbid acuteness, or sometimes dulness of the senses. The best remedies for this are opium in full, and whisky in moderate quantities, with beef-tea, so given as to sustain the patient without overpowering the enfeebled stomach.

CHAPTER XIII.

TEDIOUS LABOR.

Labor is frequently protracted beyond its usual limits by delay in one or more of its three stages, and yet it is terminated naturally. Such labors are known as *tedious*. Delays during the first stage are of comparatively little importance. There is no danger to the child (if the bag of waters be not broken), and rarely is the condition of the mother rendered unfavorable. She often is fatigued with the prolonged suffering and loss of sleep, but under the stimulus of the second stage she comes up, and in the end makes almost as rapid a recovery as in more normal cases. On the other hand, delays during the second stage are very bad for the mother, and exceedingly so for the child. The latter perishes in one case out of every four when the head remains in the cavity of the pelvis eight hours; and in the mother, shortly after that period, the uterine pains almost always become irregular and ineffective, and restlessness, rigors, hot dry skin, vomiting, very rapid, feeble pulse, dry, foul mouth, come on, showing the grave constitutional disturbance. At the same time, the pressure on the parts causes local changes. Often there comes from them a yellowish, fetid exhalation, and inflammation or gangrene is sure to follow the too protracted presence of the head. If the woman be not relieved, these symptoms are augmented to a frightful degree, and finally she falls into a half-stupid, semi-delirious condition, from which death soon releases her.

Uterine Rigidity.

The most common cause of a protracted first stage is *rigidity of the os uteri*. It is chiefly found in first labors, but does happen in multiparæ, and in women who have married somewhat late in life, and are strong and vigorous, of a tough, unyielding fibre. It is to be recognized by the hard, firm, dense feel of the os, which sometimes feels as though made of cartilage, and is not seldom morbidly sensitive. The remedies are: bleeding, which when carried to syncope is often effectual, yet must be used with cau-

tion, owing to the disastrous secondary effects which follow its use in some constitutions; if blood be taken, the orifice should be large, so as to induce relaxation as rapidly and with as little loss of blood as possible; opium, to be used in considerable doses when there are violent ineffectual pains; warm mucilaginous enemata; the warm bath; and especially ether by inhalation; belladonna ointment applied directly to the os has been much tried, but with little success. Rigidity from cancerous or other organic degeneration of the os is a terrible complication of labor, sometimes requiring the use of the knife. There is another condition of the os uteri which is often a cause of delay, where the anterior lip is caught between the head and symphysis pubis, and its retraction prevented. This may result either from an obliquity of the uterus or more probably from an unequal dilatation of the anterior and posterior lips, the latter dilating most rapidly. The remedy is simple and easily applied. During the interval between the pains, when the os uteri is soft and dilatable, the practitioner should gently push back the anterior lip over the crown of the head, and hold it there during the succeeding pains, a proceeding which, if nicely accomplished, will soon be followed by the expulsive pains of the second stage.

Another cause is a *rheumatic condition of the uterus*, to be recognized by irregular, excessively painful contractions, abdominal tenderness, scanty, high-colored urine; remedies, alkaline drinks, saline purges, Dover's powder, warm fomentations, and, rarely, bloodletting, and chloroform or ether inhalations.

Premature Rupture of the Membranes.

This may occur either through their own weakness, or from violence, either accidental, or from the officious meddling of the accoucheur. The result is, that the os uteri, instead of being dilated by the bag of membranes, which is soft and wedge-like, comes at once in contact with the child's head, which is not by any means so good a dilator. The only remedy is patience. An examination should be made early in order to correct the presentation without loss of time, should it be abnormal.

Excess of Liquor Amnii.

This is sometimes enumerated as a cause of tedious labor. The liquor amnii is apt to be in excess when the patient is feeble and the child small and ill-nourished. The treatment for this is rupture of the membranes, which should not, however, be practised without due caution, for it may produce tedious labor from the cause mentioned in the preceding paragraph.

Distended Bladder, etc.

This may retard the head, hence the rule always to keep the bladder as empty as possible during labor, strengthened by the fear of injury to the structure of the bladder itself.

Impacted feces in the rectum are another source of delay; remedy, stimulating enemata, or the removal of the obstruction with the finger or the handle of a spoon.

Sometimes during pregnancy there may arise persistent inclination of the uterus, which, when labor comes on, produces delay by causing the axis of the uterus not to coincide with that of the brim, and hence a loss of power as well as difficulty in engagement. The most common form of this is seen in women whose abdominal walls are exceedingly relaxed from having borne many children. As a result of this want of support, the fundus of the uterus falls forwards, and the pains, instead of forcing the head down through the superior strait, drive it against the upper part of the sacrum.

The DIAGNOSIS in these cases is to be made out by vaginal examination and external palpation. The indications obviously are, to replace the uterus by mechanical means, as external pressure and altering position of patient; thus, in the anterior malposition described, place the woman on her back and draw up and support the fundus by means of a towel placed across the pendulous belly.

The ordinary causes of delay, in the second stage of labor, are as follows :—

Inefficient Pains.

These are seen in persons of weak frame and constitution, or who have become debilitated in any way, and sometimes in those who have borne large families. The pains are weak, short, occurring at long and irregular intervals, often themselves very irregular and mostly accompanied by rapid pulse, and other signs of debility. Although the pelvis be roomy and soft parts relaxed, the child's head does not progress. The indications for treatment are to keep up the woman's spirits, and to rouse the flagging uterus. The means of doing the latter are warm drinks, hot stimulants, changes of posture, stimulating enemata, external frictions, electricity, and certain medicines.

Ergot is *the* remedy, but it must be used with great caution, as there is danger not only to the mother but also to the child. The contractions induced by it are constant rather than intermittent, tonic rather than clonic, and may produce the death of the child by the continuous pressure impeding the circulation of the placenta; also risking inflammation and sloughing of the soft parts of the mother; moreover, if resisted, they are often sufficiently powerful to rupture the uterus, or to cause extensive laceration of the soft parts. The indications for its use are, inefficient, feeble pains without obvious cause; if the os and soft parts be quite dilatable; if there be no other obstacles to delivery; if the head or breech present and be sufficiently advanced; if there be no threatening head symptoms. It should *not* be given, if the os or soft parts be hard and undilatable; if there be a mal-presentation or deformed pelvis; if the presentation be beyond reach; if there be threatening head symptoms. At the present time many practitioners prefer the use of *forceps* to ergot in most cases of tedious labor. Experience seems to have shown that, when skilfully applied and used, the danger of injury from the use of forceps, especially after the head has descended to the inferior strait, is not great. A bungling use of instruments, of course, is always dangerous.

Toughness of the membranes is sometimes given as a cause of lingering labor. This may obviously be overcome by rupturing them with a probe, etc.

Rigidity of the Soft Parts.

This is seen most frequently in primiparæ, especially when they are somewhat advanced in age, are plethoric, and of a robust, firm fibre. In these cases there are evident abnormal dryness, firmness, and want of dilatability of the vagina and perineum. When the head of the child reaches the floor of the pelvis it is arrested, although the pains be very powerful. If this condition of things persists, the patient will fall into a state of exhaustion and constitutional irritation, and there may be finally inflammation and sloughing of the soft parts from the long-continued pressure; in most cases, however, the parts will yield and dilate before evil results. The objects of treatment are to aid relaxation, and to prevent inflammation. The means are, moderate bleeding, if the state of the patient allow; opium, tartar emetic in nauseating doses; warm fomentations to the pudendum, and enemata; warm hip-baths; pressure of a hand on the parts, and especially chloroform or ether inhalations, as in rigidity of the os. Sometimes the rigidity is caused by *cicatrices*, the results of laceration or sloughing in former labors, of venereal ulcers, etc. These cases are often very unmanageable, but must be treated on general principles. In some cases it becomes necessary to make a small incision into the cicatrix, allowing the part to be retorn. In all cases of rigidity the patient should be prevented from making too great bearing down efforts for fear of laceration.

Ovarian or Pelvic Tumors.

These may delay labor in the second stage. In some cases the unassisted powers of nature are sufficient to overcome difficulties of this sort, but frequently instrumental assistance is requisite; when the labor becomes preternatural.

CHAPTER XIV.

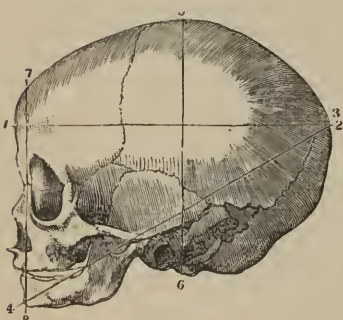
MECHANISM OF LABOR.

Fœtal Head.

As this plays a very important part in the mechanism of labor, it deserves to be carefully considered. It corresponds in form with the brim and outlet of the pelvis, in that it is oval, but it is more perfectly so than either of these; its long diameter is at right angles, or nearly so, to the face, and its short diameter is transverse to this. It is composed of the same bones and soft parts as the adult head, but differs in the circumstances that the frontal bone is divided into two distinct halves, and that none of

the bones of the vault of the cranium are closely united. In the adult these, it will be called to mind, are closely dovetailed into one another, so as to make immovable sutures which are in very old heads almost obliterated by bony deposit. Not so in the child's head; there are no closely-joined sutures between the bones of the vault, which are merely united by membrane, there being a considerable space between them. As a consequence, the head is capable of great compression, the bones riding up over one another when lateral or antero-posterior forces are applied, so that it is thus enabled to pass through a smaller space than it otherwise would be. As the nervous structures at the base of the skull are so delicate that compression of them would compromise the life of the child, the bones of this part are firmly united. The spaces between the bones are known as *sutures.* At the union of the occipital and parietal bones the suture is widened out into a small triangular space, the *posterior fontanelle;* at the junction of the parietal and frontal bones into a much larger space, the *anterior fontanelle*, sometimes called *bregma* (from Greek βρέχω, to moisten). The sutures have received special names; that which separates the frontal and parietal bones is the *corona* (Latin, *corona*, a crown), that between the parietal bones, the *sagittal* (*sagitta*, an arrow), that between the occipital and parietal, the *lambdoidal* (Greek letter λ). It is especially on the fontanelles that the obstetrician relies in making his diagnosis of position during labor, and the student must therefore become thoroughly conversant with them. They are placed at the two extremities of the sagittal suture. The anterior is quadrangular or kite-shaped, so large that the end of the finger cannot cover it, and is bounded by four separate bones, two parietal and two frontal. The posterior is much smaller, bounded by but three bones, and has, of course, only three sutures running from it.

Fig. 437.



FŒTAL HEAD.

Diameters.

The dimensions of the head vary somewhat, and are given differently by different authorities; the following may be looked upon as the average; they are substantially as given by Churchill.

The longitudinal or occipito-frontal diameter, Fig. 437, [1] [2] is from	4 to 4½ inches.
The transverse or bi-parietal, from one parietal bone to the other, is	3½ to 4 inches.
The occipito-mental or oblique [3] [4]	5 to 5½ inches.
The cervico-bregmatic [5] [6]	3½ to 4 inches.

The occipito-bregmatic	3½ inches
The inter-auricular	3 inches.
The bi-malar	3 inches.
The fronto-mental[7 8]	3½ inches.
The transverse diameter of the shoulders	4 to 5 reducible to 3.
" " " " hips	4 to 5.

Of the diameters of the head the only important ones are the occipito-frontal, bi-parietal, occipito-mental, the occipito and cervico-bregmatic.

In general it may be observed that all the measurements are larger in male than female children.

Regions of the Head.

Vertex.—A circle two inches in diameter around the posterior fontanelle. *Bregmatic Region.*—The top of the head. *Base.*—The immovable parts of the head, the sphenoid bone in the centre, the temporal bones laterally together with the bones of the face.

Presentations and Positions.

Presentations.—By this term is understood the part of the child which offers itself at the superior strait of the pelvis; *Position* being used to express the relation of such part to the superior strait. Of course there may be as many presentations as there are square inches of surface of the child, but these may all be studied under four heads: *cephalic*, including *vertex* and *face; breech* or pelvic, including hips and loins; *inferior extremities*, including knees and feet; *superior extremities*, including shoulders, elbows, and hands, or, as more commonly called, *shoulder presentations*, along with which are to be studied, presentation of back, chest, belly, or indeed any lateral portion of the trunk, since the treatment is the same. Pelvic presentations might with propriety be said to include those of the inferior extremities, thus making but three general divisions, viz., cephalic, pelvic, and transverse or shoulder presentations.

The DIAGNOSIS is of course to be made out by a study of the external anatomy of the parts presenting, by vaginal examination; more particularly the peculiarities may be stated as follows:—

Head.—Shape, hardness, sutures, and fontanelles.

Face.—Irregularity, nose, mouth, orbits of the eyes.

Breech.—Softness, and general rounded form, nates, organs of generation, tubera ischii, single prominence of the coccygis, and often the presence of meconium.

Knee.—Roundness, hardness, condyles of femurs, patella.

Foot.—Length, shape, heel at one extremity, toes (of equal length) at the other.

Hand.—Shortness, thumb and fingers of unequal length.

Elbow.—Sharpness.

Shoulder.—Rounded shape, axilla, clavicle, ribs, scapula.

Cranial presentations are by far the most numerous of the varieties that offer themselves, and of these the vertex occurs most frequently. Madame Boivin states that in superintending twenty thousand five hundred and seventeen labors, at the Maternité Lying-in Hospital, at Paris, she found fifteen thousand six hun-

dred and ninety-three cases in which the vertex presented in the first position. The greater frequency of vertex presentations has been accounted for by some authorities by gravity. According to Rich, the "fœtus hangs suspended in the liquor amnii by the umbilical cord, which is attached nearer to its pelvic than to its cephalic extremity; the head, being the heaviest part, consequently becomes dependent."

CHAPTER XV.

VERTEX PRESENTATIONS.

Positions of Vertex.

The vertex may present at the brim of the pelvis in various positions; some obstetrical writers enumerate eight; some reduce the number to four; but in most of our schools six is the number taught. These are as follows; the first three are occipito-anterior, the others occipito-posterior:—

1. Nape of the neck to the left acetabulum—Forehead at the right sacro-iliac junction.
2. Nape of the neck to the right acetabulum—Forehead at the left sacro-iliac junction.
3. Nape of the neck to the symphysis pubis—Forehead at the promontory of the sacrum.
4. Nape of the neck to the right sacro-junction—Forehead at the left acetabulum.
5. Nape of the neck to the left sacro-juuction—Forehead at the right acetabulum.
6. Nape of the neck to the promontory of the sacrum—Forehead at the symphysis pubis.

Ramsbotham and others add two other positions to these, making eight altogether: 1. The face inclining to the right ilium, the occiput to the left; the right ear behind the symphysis pubis, the left towards the spinal column. 2. The reverse of the first, face to the left, occiput to the right; right ear towards the promontory of sacrum, left behind the symphysis pubis; the remaining six follow in the order given above.

The DIAGNOSIS of the various positions is to be made out by a careful vaginal examination of the sutures and fontanelles of the head, and consideration of their relation to the maternal parts. Thus if a large kite-shaped space (anterior fontanelle) with four sutures running from it, is felt on that portion of the head, pointing towards the right sacro-iliac junction and the sagittal suture passing obliquely across the pelvis, ending in a small triangular space (posterior fontanelle) looking towards the left acetabulum, the head is evidently in the first position. In these cases, however, often the anterior fontanelle is felt with difficulty, owing to the complete flexion; and the situation of the posterior fontanelle alone decides the diagnosis. The diagnosis of the various positions, though extremely simple on paper, is often difficult in prac-

tice, especially when the head is somewhat advanced and a large "caput succedaneum" has formed. The student should endeavor carefully to study his earlier cases, so as to familiarize his finger with the various parts and their relations.

Occipito-Anterior Positions.

Previous to the engagement of the head, when it first offers itself at the brim, it is in a state of *semiflexion*. In oblique occipito-anterior positions, the occipito-frontal diameter corresponds to one oblique diameter of the superior strait, the biparietal to the other. It is evident that these diameters are not the most favorable, the occipito-frontal (four and a half inches) being too great to pass through the oblique diameter of the superior strait, encroached upon, as the latter is, by the soft structures; accordingly, when the membranes rupture, and the uterine contractions push the head into the pelvis, each uterine pain communicates a downward motion to the trunk of the child, which is transmitted through the spinal column to the head, but this is resisted by the pelvis operating as the periphery of the occipito-frontal circumference. It is evident that the expulsive force being transmitted through the spine acts chiefly on the head at the position of the occipital foramen, and therefore more forcibly on the occiput than on the forehead, being much nearer to the former. As a consequence of the inequality of the expulsive power, the occiput is forced downwards, the forehead upwards, and the child's head is bent forwards on the body, *i. e.*, *flexion* takes place. This change in the position of the head causes a change in the relation of its diameters to those of the pelvis. The occipito-bregmatic and the biparietal now correspond with the oblique diameters, the occipito-mental with the axis of the superior strait, the smaller diameters of the head therefore being in relation with the largest of the pelvis.

As the head descends, it of necessity falls upon the inclined planes, the occiput resting on the anterior, the forehead on the posterior, which is diagonally opposite. The result of the combined action of the propelling force and these planes is *rotation;* that is, during its descent through the cavity of the pelvis, the head rotates, so that the occiput comes under the pubic arch, the forehead into the hollow of the sacrum. There is thus a second change in the relations of the diameters of the head and pelvis; the occipito-bregmatic diameter now corresponds with the antero-posterior diameter of the inferior strait, the biparietal with the transverse, the occipito-mental with the axis of the inferior strait, *i. e.*, the smallest diameters of the head correspond again with the longest of the pelvis. The occiput is now arrested by the pubic arch, but the face is free in the hollow of the sacrum, the expulsive force, not being able to move the occiput, causes the face to advance; one end of the lever being fixed, the other end is moved by the force applied between them. Thus *extension* is brought about. The chin, which during flexion had been forced down upon the chest, now leaves it and sweeps around the sacral curve.

By this process of *extension* the head is brought into the world, the top of the head, forehead, eyes, nose, mouth, and chin, suc-

cessively appearing at the vulva, the head coming into the world in a position of extreme extension. The head once born immediately rotates back to the same oblique position it had on entering the pelvis. This is *restitution*. The shoulders follow the course of the head, undergoing rotation. The pubic shoulder generally remains stationary at the arch, whilst the sacral describes the sacro-coccygeal curve, and is born first. The body and hips then follow, executing, if their size require it, the same movements.

To make this more clear let us follow a head in the first position. The diameters at the brim are, occipito-frontal corresponding to the left oblique, biparietal to the right oblique, occipito-bregmatic to the axis of the superior strait. Flexion takes place, the occipito-mental diameter comes into coincidence with the axis of the strait, the biparietal corresponding to the right oblique, the occipito-bregmatic to the left oblique ; *descent* and rotation follow, and when the head appears at the inferior strait, the occipito-bregmatic diameter corresponds to the antero-posterior, the biparietal to the transverse. Arrest of the occiput ensues, and then *extension*, the chin sweeping around the sacro-coccygeal curve ; and the face is born, looking directly towards the feet of the mother. Then *restitution*, the face regaining its original oblique position, looking towards the right thigh of the mother. In the second position, when restitution takes place, the face of the child of course looks towards the left thigh of the mother.

Occipito-posterior Positions.

Owing to the wonderful adaptation of the pelvis to the needs of parturition, in a large majority of these cases rotation takes place to such an extent that the occipito-posterior position becomes an occipito-anterior, and finally the occiput gets under the arch of the pubis, and the head is born by extreme extension, just as in the first position of the vertex. Sometimes, however, this does not happen, but the head engages as it originally presents. Of course the diameters involved are the same as in the anterior positions, but the extremities of those diameters are reversed. The head as it descends rotates, as in the anterior positions, and from the same causes. As a result of this, the forehead comes under the pubic arch ; the occiput into the hollow of the sacrum. Again precisely the same diameters are involved as in the anterior positions, but with reversed extremities. Thus the occipito-bregmatic corresponds with the antero-posterior diameter of the strait ; the biparietal with the transverse. The forehead is arrested at the pubic arch, and the occiput, under the influence of the expulsive force, sweeps around the sacral curve. In other words, instead of extension, there is extreme *flexion*. The vertex is born first, and then extension takes place, so that the posterior fontanelle, sagittal suture, the anterior fontanelle, the parietal protuberances, and the several parts of the face, successively appear. Immediately after birth restitution takes place ; the face turns towards one or the other groin, as the case may be, and the occiput to the back part of the thigh.

The *third position* is so rare that many authorities are sceptical as to its existence. Madame Boivin met with it only six times in

twenty thousand five hundred and seventeen cases; when it does occur, the occiput is at the pubis, the forehead looking directly towards the sacrum; when flexion has taken place, the occipito-mental diameter of the head corresponds with the axis of the superior strait, the occipito-bregmatic with the antero-posterior, the biparietal with the transverse; the occipito-bregmatic circumference with the plane of the inferior strait. The position is precisely as in the first position of the vertex. The head is born by extension, but as there has been no rotation there is no restitution, and the face looks directly backwards. The shoulders commonly enter transversely, but rotate so as to get one under the pubis, the other into the hollow of the sacrum, and they are born as in the first position of the vertex.

The *sixth position* is like the third in its rarity, and also in there being neither rotation nor restitution. The diameters involved are the same with their extremities reversed.

CHAPTER XVI.

FACE PRESENTATIONS.

THESE may be looked on as simply variations from those of the vertex. They were formerly considered excessively dangerous, but since the dictum of Madame La Chapelle they have been regarded differently. According to her, out of seventy-two cases of the kind, forty-two were delivered by the unassisted efforts of nature, without detriment to mother or child. They may therefore be included under natural labor.

CAUSES.—The causes of face presentations are as obscure as those of other presentations generally. Madame La Chapelle attributes them to the circumstance that, the anterior obliquity of the womb being very common, the weight of the occiput must in such cases prevent the chin from being applied to the breast, and must bring the mento-bregmatic diameter into parallelism with the sacro-pubic diameter from the very commencement of labor. Perhaps it will be best here to sum up once for all the general causes of mal-positions and mal-presentations, as enumerated by Dr. Simpson.

1. Prematurity of labor; parturition occurring before the natural position of the fœtus is established.

2. Death of the child in utero; or in other words, the loss of the adaptive vital reflex actions of the fœtus.

3. Causes altering the normal shape of the fœtus or contained body, or causes altering the normal shape of the uterus or containing body, and thus forcing the fœtus to assume in its reflex movements an unusual position, in order to adapt itself to the unusual circumstances in which it happens to be placed.

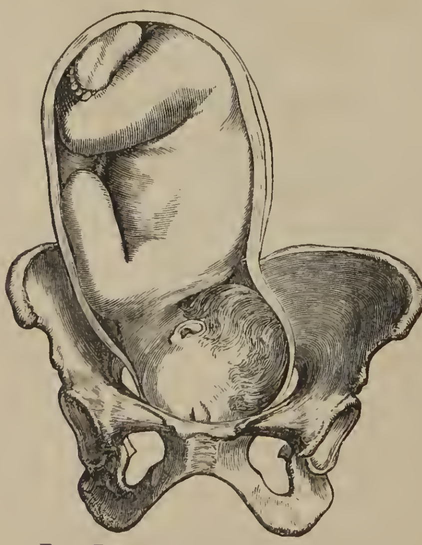
4. Preternatural presentations are occasionally the result of causes physically displacing either the whole fœtus or its present-

ing part, during the latter periods of gestation, or at the commencement of labor.

A presentation originally that of the vertex is readily converted into a face presentation by extension taking place instead of flexion at the beginning of labor. Thus, if at the commencement of labor the uterus be so oblique as to throw the fundus far over to the right side, the child presenting by the head and the vertex in the first position, the direction of the expulsive force operating on the infant will propel its head against the edge or brim of the pelvis, and either cause it to glance upwards into the iliac fossa and let the shoulder come down, or it will be turned over so as to let the face fall into the opening and thus produce a face presentation; in which the chin will be directed to the right side, and the forehead to the left of the pelvis.

POSITIONS.—Some authorities enumerate six positions of the face corresponding with the six in the vertex. But by most of the

Fig. 438.



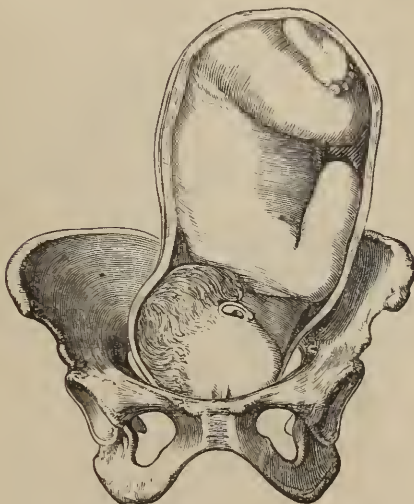
FACE PRESENTATION—FIRST POSITION.

more recent writers the number has been reduced to two. In the first of these the forehead is towards the left acetabulum or left ilium, the chin towards the right sacro-iliac junction or right ilium, the bridge of the nose representing the line described by the sagittal suture in the first position of the vertex.

Second position.—In this the forehead is to the right, the chin to the left sacro-iliac synchondrosis or left ilium. The first position of the face may be looked upon as a deviation from either the

first or fifth position of the vertex; the second from the second or fourth.

Fig. 439.



FACE PRESENTATION—SECOND POSITION.

MECHANISM.—In the first position the right side of the face is anterior and therefore the most advanced into the pelvis, and the finger in examination touches the right eye and right malar bone first. If the labor be protracted this part of the face becomes very much swollen and livid, a sort of tumor forms upon the upper part of it, the analogue of the *caput succedaneum* in vertex presentations. The face comes down more or less transversely, either with the bi-temporal diameter corresponding to the antero-posterior diameter of the superior strait, and the fronto-mental with the transverse, or else these head diameters are in coincidence with the two oblique diameters of the pelvis. At engagement extreme *extension* takes place, then *descent*. During the descent *rotation* occurs; the chin rotates upon the right anterior inclined plane until it gets under the arch of the pubis, while the anterior fontanelle glides in an opposite direction upon the left posterior inclined plane and falls into the hollow of the sacrum. The chin generally emerges first, coming out somewhat obliquely from under the arch of the pubis, and the head is born by a process of extension, the vault of the cranium sweeping around the sacro-coccygeal curve.

The second position is the reverse of the first; the left eye and zygoma are lowest and the tumor forms in the upper part of the left side of the face. The chin rotates upon the left anterior

inclined plane, the forehead upon the right posterior, but the chin comes under the pubic arch, and labor is completed just as in the first position, in fact the same diameters are involved throughout the labor.

Fig. 440.

PASSAGE OF THE HEAD THROUGH THE EXTERNAL PARTS IN FACE PRESENTATIONS.

In all positions of the face the object is to bring the chin under the pubic arch, and the mechanism is the same as in the two varieties described. Should the chin unfortunately rotate into the hollow of the sacrum, unassisted delivery is impossible if the child be full-grown. Such cases will be discussed under the head of *preternatural labor.*

DIAGNOSIS.—The only part with which the face could be confounded is the breech. The mouth has been taken for the anus, from which it is to be distinguished by the absence of the prominence of the os coccyx and of the sphincter ani, which muscle contracts when irritated by the finger in breech presentations. The various features of the face, eyes, nose, chin, must also be sought for. The best means of diagnosticating both presentation and position in these cases is by the bridge of the nose, which, from its crossing the *os uteri*, may often be detected very early in labor. The practitioner must remember the possibility of seriously injuring the eye by a rough examination of it.

PROGNOSIS.—Face presentations are more unfavorable than those of the vertex, requiring more laborious efforts for delivery, because the cephalic extremity is removed from the line of direction in which the uterus and accessory powers act, and the bones

of the face are incompressible, so that there is not the same adaptation to the parts through which it is to pass.

TREATMENT.—If called very early it is well to endeavor to bring about flexion, and thus change a face presentation to a vertex one; if this cannot be done, little is in most cases necessary, except watching carefully the case and supporting the mother. Sometimes it is well gently to aid rotation of the chin under the pubic arch, by making gentle pressure on it in the proper direction. This may be done with the fingers, or by means of the lever. There is generally great disfigurement of the child; the eyes are closed, the features swollen and livid; but this is of little importance and passes away spontaneously in a few days.

Other deviations from vertex presentations sometimes occur, and may either correct themselves or be causes of preternatural labor. Thus the head may descend in semi-extension, so that the occipito-frontal or occipito-mental diameters correspond to those of the straits. In this case either the anterior fontanelle or forehead will present itself. Sometimes the head is too much flexed, causing part of the nucha to present with the occiput. Again, the ear, a parietal bone, temple, or brow, may offer itself at the superior strait, and the head may be at last jammed into the pelvis in this position.

CHAPTER XVII.

PELVIC PRESENTATIONS.

UNDER the head of pelvic presentations are included those of the knees and feet, as well as of the breech; since the mechanism, treatment, and prognosis are essentially the same. They are said to occur about twice in every hundred cases. In regard to the PROGNOSIS, it is serious for the child, favorable for the mother. The life of the child is very much oftener lost than in vertex presentations, the immediate cause of death being generally *asphyxia*. It will be remembered that aeration of the fœtal blood takes place in the placenta, by the interchange of gases between the blood of the mother and that of the fœtus. When the child is born into the world, normal respiration is established, and the child becomes independent of the mother. It is evident, then, that anything which seriously interferes with the fœtal respiration in the placenta, or with the circulation through the cord before the establishment of respiration, must cause the death of the child by *asphyxia*. There are two circumstances very common in breech presentations that may do this. They are, detachment of the placenta from the uterine surface before the birth of the head, and pressure on the umbilical cord during the descent of the head; if one of these happens, the child inevitably perishes, unless speedily delivered. It might be thought, as the pelvic end of the child is the small end of the cone, that this presentation would be the

best for dilatation and rapid labor. This is not so, there being rarely in labor much trouble with the body; it is the head that causes difficulty generally.

In a breech presentation, when the head comes down it finds the parts imperfectly dilated, and must at any rate be forced through the mother's bony pelvis. But as the body of the child is already delivered, by the time the head is out of the uterus and well down in the pelvis, just at the point of the labor when the most force is required, the uterus is emptied and can exert no expulsive influence on the head. Usually, however, the pressure of the head on the rectum and perineum now produces an extraordinarily violent tenesmus, which causes all the muscles of the woman to strain together to bear down upon and force out the head.

Positions.—The breech may present itself at the brim in various positions, and some authorities make as many positions of the breech as of the vertex. Practically, when it enters the pelvis it arranges itself so that either the back of the child is turned anteriorly towards the belly of the mother, or else the back of the child is turned posteriorly towards the back of the mother.

Fig. 441.

Breech Presentation.

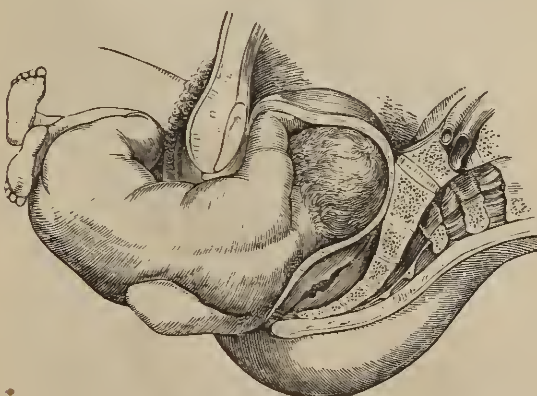
The first of these is the generally recognized first position of the breech, the second the second.

It must be borne in mind that the back of the child does not look directly, but obliquely backwards or forwards. The anterior of the two ischii is always more advanced than its fellow, and will be found lower in the pelvis, so that the nates pass through the

entrance, cavity, and outlet of the pelvis in a position which is oblique both as to its transverse diameter and as to its axis.

In the first position, the left ischium corresponds to the right acetabulum, the right to the left sacro-iliac junction. The left ischium being anterior is depressed, and is felt first at the os uteri. It comes down and passes first through the vaginal orifice, its fellow sweeping around the sacro-coccygeal curve, the belly of the child looking towards the inner surface of the right thigh of the mother. The rest of the trunk follows in this position, and as the breast approaches the inferior aperture of the pelvis, the shoulders pass through its superior aperture in the left oblique. The arms and elbows are generally pressed close to the side of the child, but not always. If they do not come down with the breast, the accoucheur should draw them down to avoid interference with

Fig. 442.



Breech Presentation.

the head. During the descent of the shoulders, the head with the chin resting closely on the breast enters the superior aperture of the pelvis, in the direction of the right oblique diameter, with the forehead corresponding to the right sacro-iliac junction. As the head descends rotation takes place, the occiput comes under the pubic arch, and the chin and face sweep over the perineum and appear at the posterior commissure. The head is thus finally born by the extreme flexion, with the face looking directly towards the anus of the mother.

In the second position, the right ischium corresponds to the right acetabulum, and is the most depressed. Its descent involves the same diameters and the same mechanism as in the preceding, the direction of its surface being reversed. It generally happens that when the body is born as far as the shoulders, it turns itself from the side completely forwards, and then to the opposite side,

so that the anterior surface of the child which was at first directed forwards will, perhaps, in an instant be directed backwards; in other words, the second position of the breech will have been converted into the first. Occasionally, instead of this, the occiput rotates into the hollow of the sacrum, and the chin to the symphysis pubis. The birth takes place then in this way: whilst the under jaw presses with its inferior surface against the os pubis, the point of the occiput with the vertex, followed by the forehead, sweeps over the perineum, so that the head is born by extreme extension.

Fig. 443.

BREECH PRESENTATION.

As, in face presentations, the cheek which is lowest is found after birth to be much swollen, so in the breech a livid swelling is generally found after birth upon that part which was the most dependent during labor, and was brought into the world first.

In regard to the DIAGNOSIS of breech presentations, there is only one important point which has not been touched upon: that is, the peculiar shape of the bag of waters before rupture of the membranes. Instead of the protruding part being obtuse, with a broad base, almost hemispherical, it is elongated, conical, cylindrical, resembling the finger of a glove somewhat in shape.

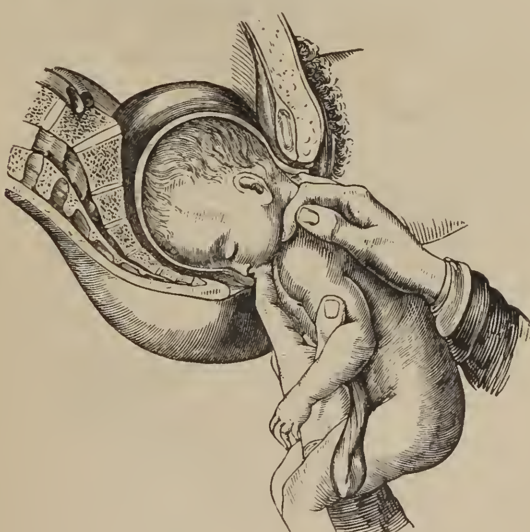
TREATMENT.—Much more care and attention are required in the treatment of these labors, than in those before described; not only to protect the soft parts of the mother, but also to preserve the child's life, which is always placed in more or less danger. It is, therefore, of great importance that a correct diagnosis should be made early. Being satisfied that it is the breech which presents, the case requires no interference until the breech shall have been expelled through the external parts, further than to guard the soft parts of the mother, and carefully to support the perineum. Above all things, the attendant should not draw down the feet, as

the inexperienced are too apt to do, in the hope of facilitating the delivery. This practice always diminishes the size of the dilating part, and thus *prolongs* the labor. As the breech escapes it should be supported and carried upwards to the axis of the pelvis, allowing it perfect liberty to change its position or make such turns as the mechanism may require. Mechanical assistance is rarely required in these cases, the child adapting itself to the passages of the mother. When the umbilicus appears at the external organs, the cord should be seized and gently drawn down and pushed to one side; this will prevent its being torn and pressed upon.

The character of the *pulsations* in the *cord* is the best *evidence we have* of the *necessity* for any *interference*. When the thorax has emerged, if the arms have not escaped with it, they should be brought down by pressing one or two fingers over either shoulder, as near as possible to the elbow, and then drawing the arm *across the face and chest*, until the elbow arrives at the external orifice; having delivered one the other is easily extracted.

The more slowly the pelvis and body pass out, the quicker will the head emerge, and the greater will be the chance of saving the child's life.

Fig. 444.



BREECH PRESENTATION—EXTRACTION OF HEAD.

The body being born, it should be wrapped in warm flannel and raised upwards on the practitioner's arm to a height sufficient to enable the longest diameter of the head to become parallel with the

axis of the vagina, and the patient should be directed to bear down. All traction must be carefully avoided, and in fact the body is to be rather held back. The reason for this is obvious—*flexion* is a necessity, and if it do not occur the head is arrested at the pelvic brim. Any pulling at the trunk would of course tend to draw the occiput down, and therefore to throw the chin up, *i. e.*, to produce *extension*, precisely what is most to be dreaded.

If the head be delayed while in the vagina, there is danger of losing the child ; the extent of this danger will be estimated by the pulsation of the cord. As in some cases the head will be found with the face in the hollow of the sacrum, the delivery may be hastened by pressing two fingers of the left hand against the superior maxilla, and forcing the chin upon the breast, at the same time carrying forwards the body of the child.

If this fail, the perineum should be held back, so as to allow the atmospheric air to enter the respiratory organs. The child in this way may be saved till the expulsive efforts effect the delivery. Sometimes forcible pressure with both hands upon the head, through the walls of the abdomen, will cause it to descend and pass out at the vulva. Should these measures fail, and the child be in danger, the forceps should be at hand and the child be delivered by their assistance. If it should happen that the body is expelled with the face anteriorly, and the chin should lodge upon the pubes, it should be carried *backwards*, and the chin be drawn down by the finger introduced into the mouth. The remainder of the delivery, and after-treatment, are the same as in the vertex presentations.

Presentation of Inferior Extremities.

Sometimes, instead of the breech presenting with the lower extremities doubled up, one (or both) of the latter may be fully extended, when we have a foot presentation ; sometimes the leg is flexed on the thigh, when it constitutes a knee presentation. It is evident that such cases are identical in their mechanism with ordinary breech presentations, but the prognosis is rather more unfavorable, since the breech, being somewhat reduced in size, does not so thoroughly dilate the soft parts, and thus prepare the way for the head. There is, therefore, more liability to delay during the passage of the head, and consequently more danger to the child.

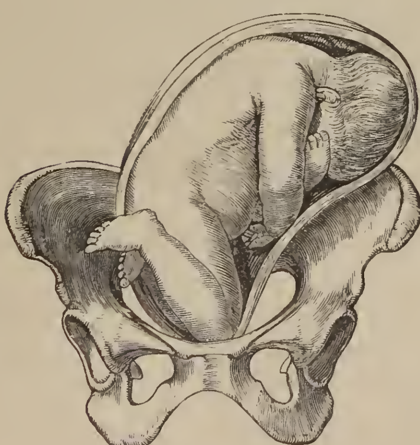
DIAGNOSIS.—The foot is readily distinguished from the hand. by the equality in the length of the toes, the presence of the heel, the rounded instep, and the ankle bones. The knee is very liable to be confounded with the elbow. For distinguishing marks, see elbow presentations.

Positions of the Feet.—Some obstetricians enumerate four positions of the foot presentation : 1. Heels behind left acetabulum, loins in front and to the left. 2. Heels behind right acetabulum, loins in front and to the right. 3. Heels behind the pubes, loins in front. 4. Heels to the promontory of the sacrum. But these, like breech presentations, are reducible to two, which correspond precisely to the same named positions of the breech : 1. *Calcaneo-anterior*—Heels directed forwards, toes backwards. 2. *Calcaneo-posterior*—Heels directed backwards, toes forwards.

Fig. 445.

PRESENTATION OF INFERIOR EXTREMITIES.

Fig. 446.



PRESENTATION OF INFERIOR EXTREMITIES.

In the same way, there are two positions of the knee: 1. Anterior surface of the leg looking to the sacrum. 2. Anterior surface looking to the pubes.

In these cases *never yield to the temptation to pull down the feet*, for reasons rendered obvious in the discussion of breech presentations.

CHAPTER XVIII.

PRETERNATURAL LABOR.

WHENEVER the long axis of the child's body corresponds with that of the uterus, the child (provided the passages are normal) can be born in that position. It matters little, as far as labor is concerned, which extremity of the child presents, so long as this is the case; but when the long axis of the body does not correspond with that of the uterus, the child must evidently lie more or less across, and will present with the arm or shoulder in a position in which it cannot be born. In stating this, we wish it understood that we refer to the full-grown living fœtus, and not to one which is premature, or which has been some time dead in the uterus. Hence the positions of the child at the beginning of labor resolve themselves into two divisions, viz.: where the long axis of the child's body is parallel to that of the uterus, and where it is transverse. In the former the birth of the child, without external aid, is possible; in the latter, with some rare exceptions, it is not. In one case the labor is natural, in the other preternatural.

Preternatural labor, or *dystocia*, signifies a faulty or irregular labor, the course of which is unfavorable, and in which the assistance of the obstetrician becomes necessary. It will be remembered that this definition applies to all cases of labor, without reference either to presentation or position, in which the manual assistance becomes necessary.

The causes that render labor difficult depend either upon the mother or the child. Some of them are unforeseen, and do not occur till the moment of parturition; the title of *accidental* may be appropriated to these. Others exist beforehand, and render labor necessarily difficult; they merit the denomination of *pre-existing* causes.

The accidental causes are, any serious disease, such as inflammation of the brain or its coverings, the lungs, pleura, peritoneum, or uterus, etc., which takes place during labor; any hemorrhage sufficiently abundant to endanger the life of the mother or her offspring; convulsions, syncope, laceration of the womb, etc., and some positions which do not become bad until after the first pains.

The *pre-existing* causes are, deformities of the pelvis, malformation or disease of the organs of generation, calculus in the bladder, fibrous or other tumors in the excavation; deformities in

respect to height; transverse positions; monstrous conformation, and diseases of the fœtus.

As these different causes are in reality only complications of labor, it follows that *dystocia* comprises all cases of complicated labor, as *eutocia* comprehends all simple labors.

From the occurrence of any of the above mentioned causes, one of the following operations may become necessary, to wit: *turning*, the *application of the forceps*, *craniotomy*, *embryotomy* or *Cæsarean section*. The first of these most frequently becomes necessary in cases of transverse positions of the child, as in presentations of the shoulders. As the mode of proceeding is the same wherever the operation becomes necessary, it will be described only in cases of *shoulder presentations*.

Transverse Positions.

Under this head may be considered all those cases in which some portion of the child presents except the cephalic or pelvic extremities; whether such parts be the shoulder, superior extremity, back, or side. It is evident that in these cases the child lies across the pelvis, *i. e.*, its long axis is transverse to the pelvic planes, hence they are called *cross births*. There are no symptoms manifest before the commencement of labor by which we are able to diagnose a cross birth. If the breadth of the uterus is markedly exaggerated, it would point somewhat towards such a presentation, but excess of the amniotic liquid or presence of twins will also induce this abnormity. It is very difficult to recognize with certainty in the *commencement* of labor: we may suspect it—if the child be so high up as not to be reached by the fingers, since, when the shoulder presents, the fœtus cannot descend into the pelvis in the same way as when one extremity offers itself—if the os uteri, although soft and flaccid, opens very slowly—if, after the membranes rupture, the uterus ceases action for some hours, for it often happens in such cases that the pains which had been active before the giving way of the bag of waters intermit entirely upon the rupture.

But we can only positively detect a cross birth by distinguishing the different parts of the child, by tactile examination and carefully noticing their relations with the maternal organs. If such a case be left to nature, one of three things must happen: either the uterus continues to contract more and more powerfully, forcing the child with the body doubled up, down into the pelvis, which is very gradually more and more compressed, and advances until at last it is expelled in this position through the inferior strait; or the uterus at length wears itself out in the vain attempt to expel the body, which is jammed in the pelvis; or it may in some terrific contraction rupture its muscular fibre by its own effort. The first of these contingencies, the doubled expulsion, the "*spontaneous evolution*" of Denham, has been known to occur, but it is very rare, except in premature births; the last, or rupture of the uterus, is an accident much to be dreaded, and almost of necessity fatal.

Fig. 447.

Fig. 448.

Fig. 449.

Fig. 450.

STEPS IN SPONTANEOUS EVOLUTION OF AN ARM PRESENTATION.

The various transverse presentations are: 1. Shoulder; 2. Elbow; 3. Hand; 4. Side; 5. Back; 6. Sternum; 7. Abdomen.

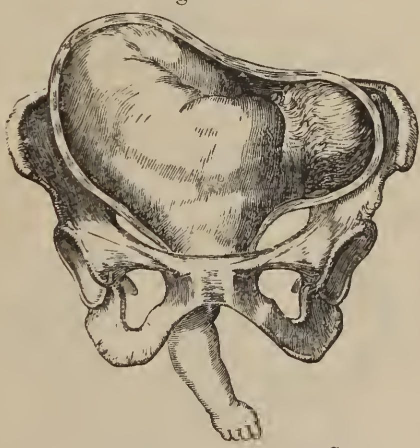
Shoulder Presentation.

The positive marks are, the pointed acromion most dependent, the spine of the scapula posteriorly, and the clavicle and perhaps the ribs anteriorly; being able to get the finger within the axilla without encountering anything like the genitalia.

Elbow.—Of all the points of the body it is most difficult to discriminate between an elbow and a knee. In the knee, however, we have the rounded patella, with its flat surface, which is more or less movable on the condyles, except in certain positions of the leg in which it is fixed by the rigid rectus muscle. In the elbow there is the olecranon, sharper than the patella, without any flat surface, and immovable. Still, the diagnosis is often doubtful. If no part of the child's body except the presenting limb can be felt, it would be allowable, if the membranes were broken, gently to draw down the folded member, *avoiding all traction*, so as to ascertain whether it be an arm or a leg.

Hand.—This is to be distinguished from a foot by the presence of a thumb, the unequal length of the fingers, the flattened palm, and the absence of the rounded instep and the heel.

Fig. 451.



Dorso-Pubic Position of the Right Shoulder.

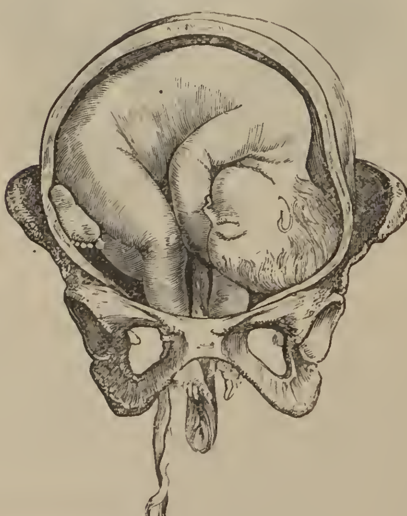
Side.—The side is to be distinguished from the various parts negatively by the absence of their peculiar signs; positively by the spaces between the ribs. These latter have been mistaken for sutures, and, in consequence, the side for the head. In any case of doubt, two or more fingers should be introduced into the uterus, and the long parallel furrows traced out.

Back.—This is to be recognized by detecting the points of the vertebral spines and the origin of the ribs.

Fig. 452.

Dorso-Sacral Position of the Right Shoulder.

Fig. 453.



Compound Presentations—Hand, Foot, and Funis.

Sternum.—This very rarely offers itself. To recognize it when present it is necessary to introduce two fingers and feel the sternal bone giving off the ribs with the interspaces between them.

Abdomen.—The rarest presentation of all: the positive mark the insertion of the umbilical cord.

Then we have two positions of each shoulder, which are sometimes called the dorso-pubic and dorso-sacral of the right or left shoulder, as the case may be.

Right Shoulder.—First position, *dorso-pubic.* Head of the child to the left of the mother, back of the child towards the front of the mother; if the hand protrude, the palm of it will look obliquely backwards. Second position, *dorso-sacral.* Head of the child to the right of the mother, the back looking towards the sacrum; if a hand protrude, the palm will look obliquely forwards.

Left Shoulder.—First position, *dorso-sacral.* Head to the left of the mother, the back looking towards the sacrum. Second position, *dorso-pubic.* Head to the right of the mother, back looking towards the pubis.

TREATMENT.—In trunk presentations the child cannot be born because its long axis is transverse to the pelvis, and the indication is obviously therefore to cause the long axis of the child to coincide with that of the pelvis, which can only be done by turning. The operation of *turning* or *version* is, then, "the act of turning the child by hand and bringing one of the extremities of its great diameter to the superior strait."

Version.

There are two varieties of this operation, namely, *podalic version*, or version by the feet, and *cephalic version*, or version by the head.

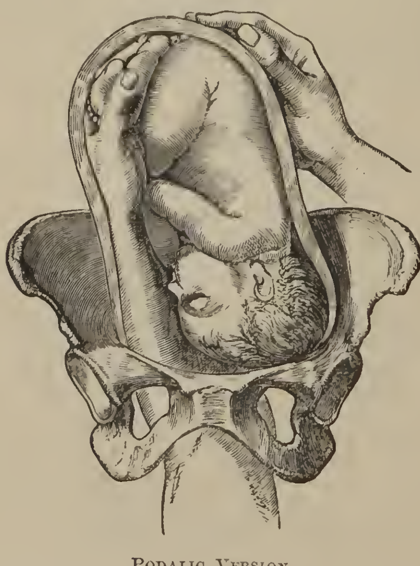
In cephalic version the presenting part is pushed away, and the head brought down in its place; the case is then left to nature. This is the safest variety for the child, but is very rarely performed to remedy a true cross birth, because the rounded, smooth, slippery head cannot be well grasped *in utero*, and brought to the os. Sometimes, when there is merely a malposition of the head, this is remedied by a sort of cephalic version. Version of the breech is never performed, since the same difficulties beset the operation as in turning by the head, and the safety of the child is not so thoroughly insured.

Podalic version is the operation which is almost exclusively employed all over the civilized world, in these cases of transverse presentation. It is used not only in such cases, but also at other times, when in order to save the mother immediate delivery is requisite; also in certain cases of pelvic distortion. The dangers of it to the woman are very trifling, and it affords a good chance of saving the child. Essentially it consists in carrying the hand up into the uterus and there seizing the feet and bringing them down.

In regard to the time at which the accoucheur should operate, the rule is to turn as soon as the uterus is sufficiently dilated to readily admit the hand, if the presentation be accurately made out. An os that will allow the entrance of the fingers and thumb when folded together to form a cone, if soft and dilatable, will admit

the whole hand. Before the rupture of the membranes there is little difficulty either in seizing the feet or in turning the child, but when the waters have escaped it is far otherwise. The uterus is then closely contracted around the child, and the entrance of the hand excites such violent pains, that the arm is often paralyzed by the contractions of the viscus, and if the feet are finally found, the rigid walls resist the change in the child's position. Before operating, the bladder and rectum must be thoroughly emptied, and the patient made unconscious by the inhalation of ether or chloroform; she will thus be free from suffering and unable to make resistance or withdraw herself from the hand of the accoucheur, the parts being at the same time relaxed and in favorable condition for the operation. The patient should be placed in the position most convenient to the operator. Some recommend that she lie upon her back with her hips at the edge of the bed and her thighs supported by assistants; others prefer the ordinary position on the left side. The thighs must always be flexed upon the abdomen to relax the muscles, and widely separated to enable the operator to move freely.

Fig. 454.



PODALIC VERSION.

The choice of the hands depends upon the position; the rule is to use that hand *whose palm when opened in the cavity of the uterus will look towards the front of the child.* This is absolute when the bag of waters has been long broken, but unimportant when it is still intact. The coat should be taken off and the arm bared to the

shoulder, and the *outside* of the hand should be well anointed with lard. The palm of the hand has to grasp the already too slippery child. The hand doubled into a conical form may now be *gently* insinuated through the os. *Gentleness and patience* must be the watchwords throughout. Through the whole time the hand must be kept quiet during the pains, and the various steps must be performed in the intervals.

When the membranes are unbroken care must be exercised not to rupture them at the os, but to carry the hand up between them and the walls as far as possible. The hand should glide along the surface of the fœtus, and when a foot is found, examine carefully, lest a mistake be made; if possible seize its fellow and draw them first downwards and *forwards as regards the fœtus*, i. e., over its front, not over its back. The liquor amnii being retained, it is like turning in a "bucket of water." During all this time the fundus of the uterus should be supported externally by the disengaged hand, which is frequently able to render material aid during the operation. When the feet are brought to the superior strait, the case is resolved into one of feet presentation, and must be treated accordingly. The version proper must all be done as far as possible during the intervals; the extraction during the pains. If the membranes have been ruptured before the operation, even greater patience and persistent gentleness must be used and all force scrupulously avoided.

When the operation of turning becomes impossible, the mother may be delivered by the total destruction of the child through decapitation or evisceration.

CHAPTER XIX.

OBSTETRIC INSTRUMENTS AND OPERATIONS.

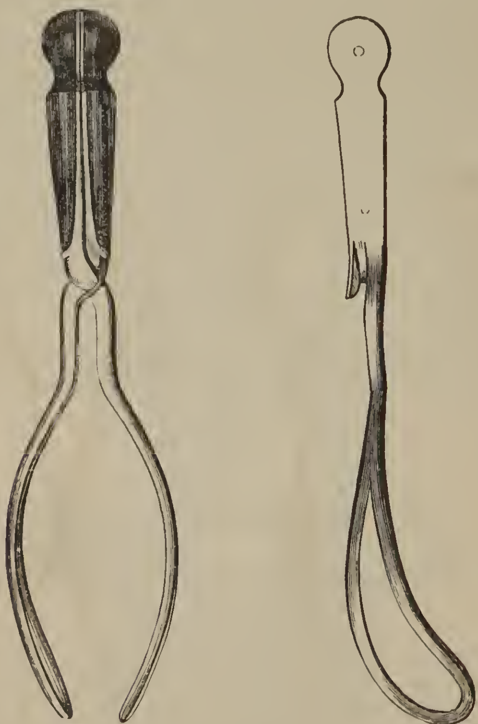
THERE are many cases of labor in which it is expedient, in order to afford the best chance for life both to the woman and child, to aid the powers of nature by certain artificial means other than simple version. The chief of these measures are the *forceps*, *vectis*, *fillet*, *blunt hook*, and the operation of *Cæsarean section*. Sometimes it is necessary to sacrifice the child in order to save the mother, when *craniotomy*, *decapitation*, or *evisceration* is resorted to.

The Forceps.

These instruments are, as far as known, entirely modern in their invention and use. The merit of their invention appears to belong to Dr. Paul Chamberlain, by whom and his sons they were long kept profoundly secret; but, about 1715, the mode of their construction and application was made public. Since this time these instruments have suffered almost endless modifications, retaining

always the expression of the original idea. These various patterns are arrangeable under two heads, the *long* and the *short forceps.* The English generally prefer the short, the Germans and French the long forceps. In this country both, perhaps the long more generally, however, are used.

Fig. 455.



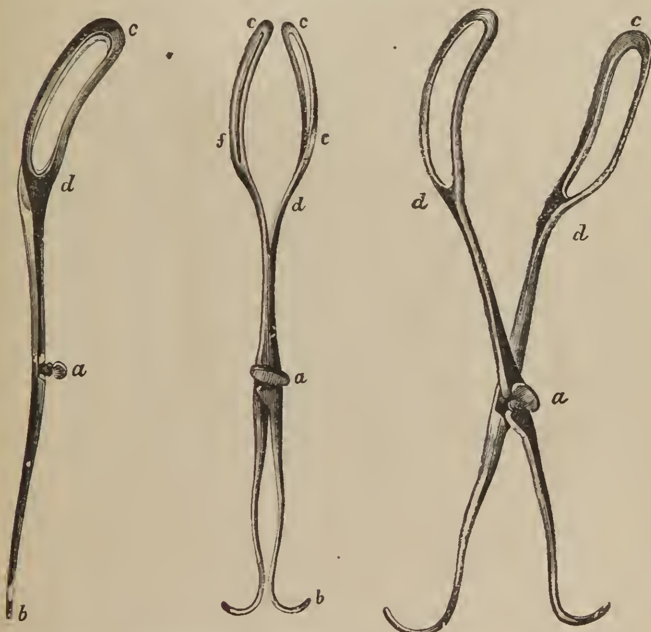
SHORT FORCEPS.

The forceps are emphatically beneficent instruments, since they not only do no harm to the mother when properly used, but also are frequently the means of saving the life of the child. They are intended for the extraction of the child's head and *nothing else*, and must never be applied to other parts of the body. They possess a threefold power ; acting as *compressors*, *levers*, and *extractors.* When they grasp the head, they, in virtue of their compressing action, slightly elongate it and lessen its transverse diameters, and thus favor its passage. At the same time they may be used

as a lever of the first kind to influence the head, and especially as a means of applying direct traction.

The forceps, like a pair of scissors, consist of two pieces, which are capable of being introduced separately and then conjoined so as to act together; the act of conjoining is technically known as *locking*. The half used by the right hand is called the *right hand blade*, or the *female blade*, that used by the left hand is the *left-hand blade*, or the *male blade*. Each consists of three parts: the blade proper or clam, the lock, and the handle; in some instruments one handle terminates in a blunt hook. The blade ought, if practicable, to be applied to the side of the child's head, not to the face or vertex, and should extend from the vertex to the chin. It is provided with an open space in the centre called the *fenestra*

Fig. 456.



a. Lock. *b.* Blunt hook. *c, d.* Clam, or blade proper. *e, f.* Fenestræ.

(window), which not only lightens the blade but also enables it to be fitted more closely to the head of the child. The lock consists either of a pivot on one blade (the male), and a notch in the other (female blade), into which it fits; or else a notch in the upper surface of the left-hand blade fitting with a notch in the lower surface of the right-hand blade. The former lock is the German, the latter the English.

The original forceps (and even now some English forceps), were *straight* in the direction of their length, that is, they had only one curve, that which applied itself around the child's head, and when *in situ*, their long axis did not correspond with that of the pelvis. Nearly simultaneously Drs. Smellie and Levret gave to the blades such a longitudinal curve as adapted them to the pelvic axis. This very important modification is known as the *new curve* in some of the older works (Fig. 455).

Professor Hodge, late of the Pennsylvania University, claimed for his "eclectic" forceps a combination of the advantages of both short and long forceps (Fig. 456).

Indications for Use.—Forceps are to be used when the powers of nature are not sufficient to meet alone, without too much delay, any resistance which their aid will enable them to overcome. They are not to be applied on the one hand until it is apparent that the obstacle cannot be overcome by the unaided powers of the mother, without compromising the safety of mother or child; nor, on the other hand, when the child cannot be extracted without laceration or serious contusion of the soft parts of the pelvis. In regard to the time of their use, it must be remembered that the dangers from *delay* are greater than those of too early application; a head jammed in one position for five (some even say two) hours of hard labor would be an imperative indication for their application, provided the difficulty was one which they could overcome; six hours of powerless labor, with the head in the pelvis, would be the extreme limit of our waiting. Sometimes, in protracted labors, we are able to discover *weakening* of the *sound* of the *fœtal heart;* in such a case the forceps ought to be put on immediately to save the child's life. In prolapsus of the funis, with pulsations still in the cord, for the same reasons, the same treatment is required. *Various malpositions* of the head call for their use; *face presentations* sometimes require them; an abnormally large head, which is not hydrocephalic, may render them necessary. They should always be applied in natural or artificial *breech presentations* when there is much delay of the head in the pelvis, as offering the best chance for safety to the child. *Convulsions*, *hemorrhage*, or *rupture of the uterus*, may, under certain circumstances, make their use expedient. *Slight pelvic distortion*, or abnormal *smallness* of the pelvis, *absence of efficient uterine pains*, etc., are other circumstances which may indicate their use.

The first stage of labor must be completed before their application, *i. e.*, the *os uteri* must have fully dilated. The most favorable position of the head for their use is at the inferior strait, especially if rotation has taken place, but they may be put on at any time after the full dilatation of the os, even before the head has passed the superior strait. As the forceps should, if possible, be applied to the side of the head, over the ears, at right angles to the transverse diameter and parallel to the occipito-mental, the *position* ought always to be first accurately determined.

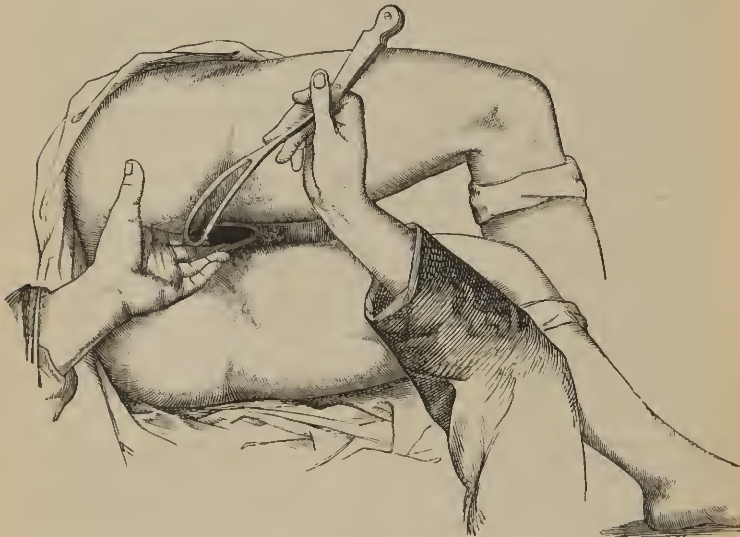
Preparations for Operation.—Before operating, the use, safety, and necessity of instrumental aid should be explained to the woman, so as to quiet her nervous fears. The rectum and bladder must be thoroughly emptied. It is not necessary in ordinary cases to use an *anæsthetic*, as the sensations of the patient are by some supposed

to be useful guides during the operation, any sudden severe pain acting as a warning that the soft parts are being pinched or bruised. In this country it is customary to put the patient on her back with her hips slightly elevated and placed at the very edge of the bed, her thighs and legs being well flexed, and each foot resting on a chair. A sheet should be thrown over her to guard her person from exposure, and a piece of oil-cloth or old comfortable, upon which is placed a wash-basin or bucket, should be laid on the floor to catch the discharges and protect the carpet from becoming soiled. Before application the instruments should be warmed, and, as well as the external genitalia, well anointed with lard, cold cream, or other mild fatty preparation. It is well at this time to confirm our previous diagnosis of the position of the head.

Operation.—Occipito-Anterior Positions.—When the head is at the inferior strait, rotation having taken place, the *left-hand* or *male blade* is to be held in the left hand much as a writing pen is held, whilst two or more fingers of the right hand are introduced into the vagina, so as to lie between the side of the head to be first operated on and the pelvic wall, and to reach as far as the os uteri. The handle of the blade is now raised up to the right of the mother in such manner that when the point of the clam is applied to the vulva it will correspond to its axis. The blade must now be very gently introduced, the right hand guarding the maternal tissues, the point closely hugging the child's head. *No force* must be used. Any obstruction which may be met with must be overcome by gentle persistency. In proportion as the blade passes into the vagina the handle must be brought down and towards the median line; the rule is to elevate and depress the handle in such a way as to keep the long axis of the blade constantly parallel to that of the pelvis. The blade follows the left posterior inclined plane until it has been placed along the side of the child's head with its plane at right angles to its parietal diameter. An assistant now takes the handle and holds it steady whilst the *female* blade is taken in the right hand of the operator. The method of its introduction is the counterpart of the preceding, the hands being reversed. If properly applied the blades now cross one another and perhaps lock without difficulty. If they do not lock readily no force must be used to make them; a little tact will frequently cause them to do so, if not, the right-hand blade must be taken out and reintroduced. If they do not lock, they certainly have not properly seized the head. Care must be exercised not to pinch the external genitals, or to catch the pudendal hair in locking. When the instruments are applied, slight compression and traction must be made in order to be sure that the soft parts of the mother are not included in the grasp, and that there is a proper adjustment of the blades to the child's head. *Introduction* is to be performed in the *intervals* of the pains. *Extraction during* the pains. As soon as the pain comes, extraction must be made partly by direct traction on the head in the *direction* of the *sacro-coccygeal* curve, partly by compression of the head, and partly by swaying the instruments to and fro, thus using them as levers. Unless there be some urgent necessity for immediate delivery, all efforts must be avoided during the intervals, the woman being allowed to rest as in natural labor

and the compression being taken off of the head of the child. Great care must be exercised to support the perineum as the vertex stretches it, and to carry the handles of the forceps upwards towards

Fig. 457.



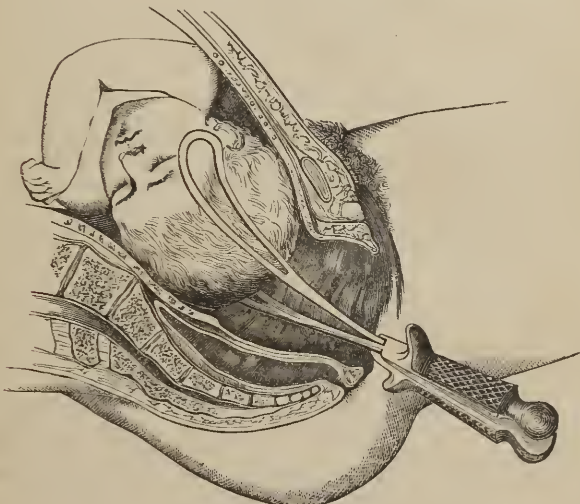
the abdomen of the mother, so as to cause the head to execute the same movements as when expelled by the unaided pains. When the head is born, the forceps should be taken off, and the labor be completed by the unaided powers of the woman. Sometimes it is requisite, however, to hasten the exit of the body by properly directed traction.

In all cases the applied forceps should be so situated in the vagina that the concave edges of the blades should look more or less directly towards the pubic arch, and the convex towards the sacrum. In the operation just described, after rotation the lock looks upwards, the concave edges being directed towards the symphysis pubis, and the convex coinciding with the hollow of the sacrum. When the forceps are applied in the first position before rotation, the lock looks upwards and obliquely towards the left thigh, the forceps being oblique in the pelvic cavity. The same general rules are to be observed in their introduction as after rotation, and traction is to be made upon the same principles, the necessity of rotation as descent takes place, and the peculiarities of the pelvic curve being borne in mind.

Second Position.—Introduce the male blade as before; but when applied it occupies so much of the anterior commissure as to leave

insufficient space for the introduction of the female blade. To obviate this, retract the male blade a little, till it is opposite the left ischium, and then, giving it in charge of an assistant, introduce the female blade to its proper place; now pass the male blade up

Fig. 458.



to the position under the ramus of the left pubis, and lock as before; the handles will point towards the right thigh, and the lock will look upwards and to the right. Make traction as in the first position.

Third Position.—In this the application and mode of extraction are much as in the first and second position after rotation.

Occipito-posterior Positions.—In the sixth position, when the occiput is in the hollow of the sacrum, the method of the application is similar to that just described. But when the head has progressed as far as the inferior strait, extraction is somewhat differently performed. We are not in such a case to draw in the direction of the axis of the strait, because the occiput has to be delivered first at the anterior perineal commissure. In the beginning of extraction the handles of the forceps should be carried upwards in order to flex the head still more on the chest, and thus bring the occiput to the perineal commissure. When this is done moderate traction may be made, the handles being at the same time depressed towards the anus.

In the *fourth and fifth positions*, after rotation, the method of ap-

plication and mechanism are precisely as in the last, unless such positions have been converted by rotation into anterior positions. Before rotation, the introduction must be performed precisely as in the corresponding anterior positions (first corresponding to fifth, second to fourth). Traction should be made in the direction of the pelvic axis, and the occiput be allowed to rotate in the hollow of the sacrum. In natural labor, when anterior rotation of the occiput takes place, the body of the child in the uterus turns with the head; but if we attempt to force rotation with the forceps, there is great risk of the firmly-contracted uterus holding the body fast, and in consequence fatal twisting of the child's neck.

According to Velpeau, there are certain irregular transverse positions of the head, in which the female or right-hand blade should be introduced first. In these the occiput is to the left, the forehead to the right ilium. The right-hand blade is to be introduced and conducted carefully in front of the right sacro-iliac junction, as high up as the forehead; then by the assistance of the fingers of the left hand placed under its convex edge, and in concert with the right hand, move it from behind forwards and from right to left, until its concave edge is turned towards the left iliac fossa, and the blade has arrived upon the left parietal protuberance. The handle, strongly depressed, is then given to an assistant, who holds it against the woman's left thigh. The left branch is held in the left hand, and passed up along the posterior part of the pelvis, until its point is above the superior strait, and the pivot even with the mortise that is in the other branch. After having joined them and dislodged the head, if it be still in the superior strait, and having forced the occiput to descend into the excavation, provided it were not already there, the concave edges of the instrument are gradually brought forwards, and the remainder of the operation is conducted as in the occipito-pubic position.

Dr. Meigs describes a similar operation where the head is transverse, but lower in the pelvis, as follows:—

"When the instrument has grasped the head in this position, the handles will project very much towards the left thigh in abduction; but if we introduce the male blade first, inasmuch as its handle will project towards the left thigh, it will occupy all the space on that side, and prevent the insertion of the second branch, for there is no place in which to depress the handle. To avoid this difficulty, take the female blade in the right hand, and introduce it into the posterior and right side of the vagina, causing its point to sweep over the face to the right side of the head, behind the pubis, leaving the handle to project towards the left thigh. Next take the male blade into the right hand, and turning the concave edge of the new curve downwards, insert the point into the right side of the vagina below the female branch. Let the fœtal face of the clam apply itself to the convexity of the head and slide it onwards, and in proportion as it enters, make it sweep round the crown of the head towards the back of the pelvis. In effecting this, the handle gets gradually down as the clam gets on the left side of the cranium, and at last the lock is found where it

ought to be, viz., under the upper or female blade, with which it is then locked."

Having ascertained that the head is grasped, rotate and proceed as before.

In some cases of *impacted head*, it happens that the head is transverse, *i. e.*, one parietal protuberance is jammed against the pubis, the other against the promontory of the sacrum. In such a case there is not space enough at those two points to apply the forceps in the usual way, and it is necessary to apply them to those parts of the head which are free from great pressure; one blade, therefore, fits over the occiput, while the other grasps the face.

After their application the handles should be well pressed together to prevent the clams from slipping. The motion from handle to handle, assisted by the traction, will generally be sufficient to disengage the head, after which the forceps may or may not be used, as the indications may direct.

When in pelvic presentations the body has been delivered and the head arrested, the method of procedure is as follows: If the face be in the hollow of the sacrum, wrap the body in a dry, soft napkin, raise it up over the parts of the mother, and let it be held nearly perpendicular; then introduce the left branch, applying it from the chin to the vertex, follow it with the right, adjust and extract, remembering the rules given for vertex presentation.

If the occiput be in the hollow of the sacrum, the forehead to the pubic symphysis, carry the body protected as before, back over the perineum as far as can be done with safety to the neck, and introduce the forceps in front of the body. In extracting the head, apply the force in such a way as to cause the chin and forehead to emerge from under the pubic arch.

In all breech presentations, the trunk is to be turned towards the direction in which the occiput looks, and the forceps are to be applied in such a way that the concavity of their edges may be towards the front, or be brought there during the progress of the operation.

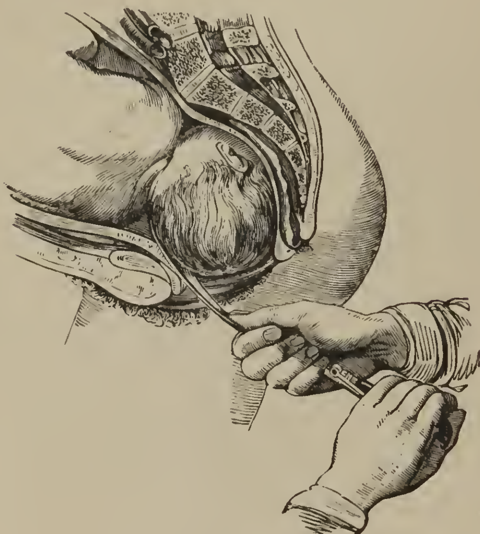
Vectis or Lever.

A just idea may be obtained of this instrument by considering it as one blade of the forceps, a little lengthened and enlarged, with the handle straight and placed in a direct line with the blade proper, *i. e.*, without any lateral curvature. The general conditions and circumstances of labor under which the use of forceps is allowable, are those under which the vectis may be employed. There are two ways in which it may be used, the first as a lever, the second as a tractor. As a lever, it has been employed to correct malpositions of the head, and to aid in the normal rotation. If used as a lever of the first kind at all, the *hand* of the accoucheur and *not the maternal soft parts* should be made the fulcrum.

When used as a tractor, the instrument is introduced very much as a single blade of the forceps, the point carried fully over the child's head, and the handle grasped tightly and held firmly by one hand, while the shank of the instrument is embraced by the other, and a movement, that of steady traction downwards, should

be given by the hand which embraces the shank, thus converting the instrument into a lever of the third order (Fig. 459). All efforts are to be made during a pain.

Fig. 459.



Application of Vectis.

The vectis is neither so efficient nor safe an instrument as the forceps, and is in this country very seldom used.

Fillet and Blunt Hook.

The first consists of a strip of silk, soft leather, or strong cloth formed into a running noose, and intended to be introduced over the head as best may be; when this is done the extraction is to be accomplished. This has been discarded entirely in head presentations, and even when applied to the groin or axilla, it does not answer so well as the blunt hook. It is now scarcely ever used, except possibly sometimes to confine the hand in shoulder presentations where turning is necessary.

The *Blunt Hook* is applied to the groin in breech cases, and to the axilla when the shoulders are delayed. In breech presentations, when the body is born and the head delayed, it has been recommended to try the blunt hook in the mouth, and, if that fail, to fix it in the lower edge of the orbit, in order to increase flexion and hasten the expulsion of the head. Such a proceeding, unless the child is dead, can scarcely be justified; the forceps would be the proper instrument.

Craniotomy.

The object of this operation is, by sacrificing the child, to terminate the labor with safety to the mother, in cases where from a disproportion between the fœtus and the pelvis, the child cannot be born through the powers of nature or the aid of *any operative procedure*, not destructive to the life of the child, except the Cæsarean section.

The case presupposes *actual disproportion sufficient to prevent the passage of the head even when compressed, and yet not so great as to prevent the extraction of the child when mutilated.*

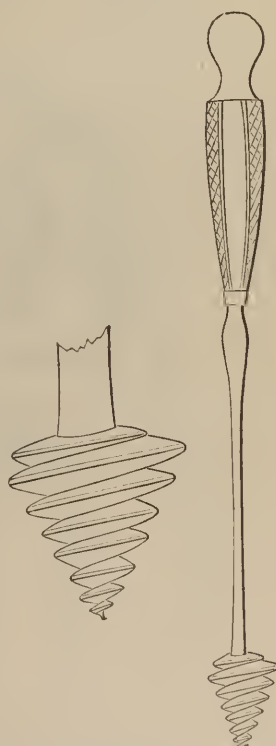
Most authorities agree that when the antero-posterior diameter of the pelvis is less than *three inches* a living child at maturity cannot pass. If the antero-posterior diameter is less than *two inches* the mutilated head cannot be extracted unless by incurring such peril to the mother that the Cæsarean section is preferable.

The disproportion may arise as well from abnormities in the child as in the mother. Thus, excessive size of the head, whether arising from hydrocephalus, hypertrophy of the brain, or simple excess of formative force, as well as cancerous or other tumors of the abdomen or elsewhere, may call for the operation. Of course, if the child be dead there will be much less reluctance in undertaking this method of relief.

When the operation is required it should not be too long delayed, for by the protracted efforts the vital powers of the mother become exhausted, and the most serious consequences may happen to her soft parts, from the long-continued pressure, such as sloughing of the vagina into the bladder or rectum, or both, and the consequent formation of vesico-vaginal, recto-vaginal, or vesico-recto-vaginal fistulæ, with all their horrid train of sufferings. Shiverings, repeated vomitings, brown, dry tongue, anxious countenance, running pulse, are some of the urgent symptoms, which ought not in these cases to be waited for.

In some cases where the sutures are very loose, the evacuation of the brain is sufficient, as the bones of the head collapse so much under

Fig. 460.



Harlow's Cranial Screw.

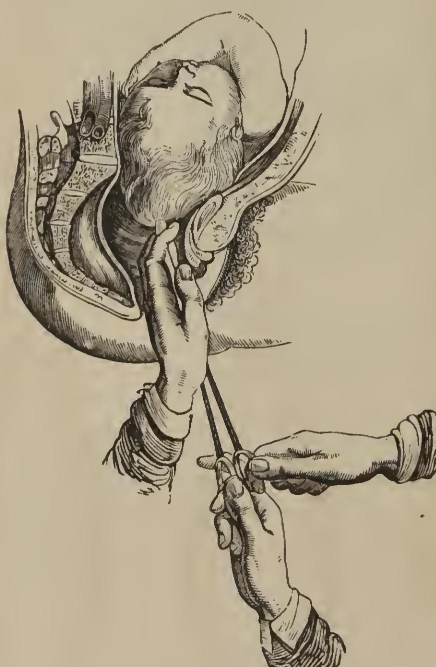
the influence of the resistant and expulsive forces of the woman, that the child may be expelled by the natural powers. Of course this can occur only when the pains are strong and the patient not exhausted. In other cases, not only must extractive force be used, but at times it is necessary to remove the bones of the head piecemeal.

The instruments are of two kinds, one set for perforating the skull, the other for extracting. The number of perforators which have been invented is legion. The only one necessary to mention here is *Smellie's Scissors*, which are scissors with short blades, terminated by an abrupt shoulder, and with the cutting edge on the outside instead of inside. A simple trocar is preferable.

Dr. Harlow's cranial screw (Fig. 460) is a convenient, safe, and efficient perforator.

Various bone forceps, the sharp crotchet, blunt hook, cephalo-

Fig. 461.



Opening the Head.

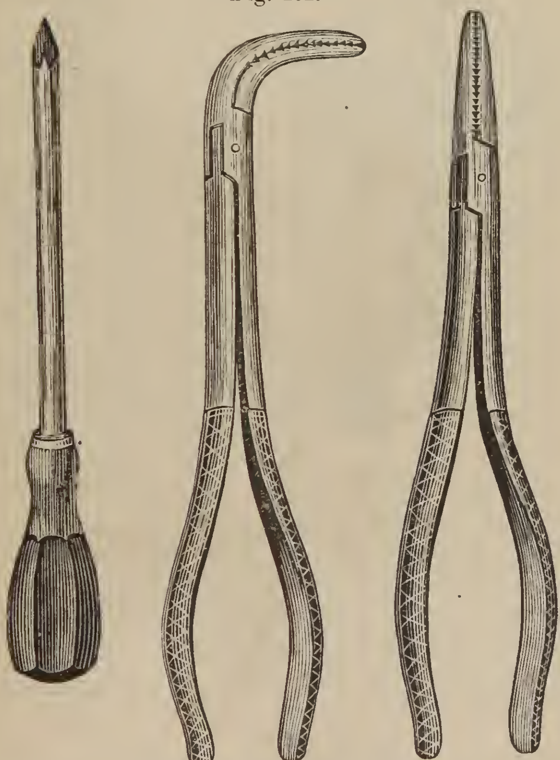
tribe, etc., are used in extraction. For detailed descriptions of these, the student is referred to larger works on Obstetrics.

It is not absolutely necessary for success, that the os uteri be

entirely dilated, although the wider the orifice the less the danger. The rectum and bladder should be emptied, and the woman, rendered insensible by an anæsthetic, should be placed in the same position as for the use of the forceps. The perforator should then be carefully applied upon the groove between the two fingers of the left hand, previously introduced, and placed upon the part of the head which it is proposed to open. It must now be passed forwards with a semi-rotatory drilling motion until it penetrates the bone. If the scissors be used they must now be as widely opened as possible, then placed at right angles to their former position, and again be opened so as to make a crucial incision.

The instrument must be plunged into the brain, and the latter broken up. After the withdrawal of the perforator, the forceps

Fig. 462.



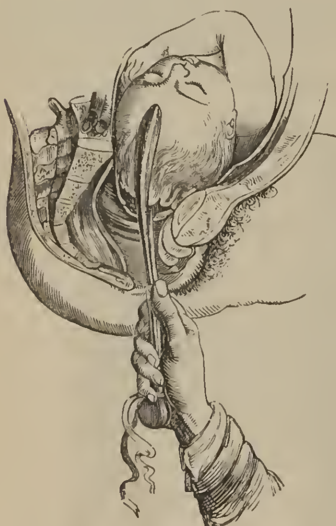
Meigs's Craniotomy Instruments.

may be applied to crush the head, or the crotchet may be introduced in the same manner, and extraction be practised very

carefully. If this do not suffice, recourse may be had to Meigs's craniotomy forceps, bone forceps, ordinary forceps, or the cephalotribe, etc.

The AFTER-TREATMENT should be conducted on general principles. Opium and moderate stimulation may be used to combat nervous shock, warm fomentations and injections for the relief of the maternal soft parts, and, if inflammation arises, appropriate antiphlogistic measures.

Fig. 463.



THE CROTCHET IN POSITION.

Fig. 464.

CRANIOCLAST.

A modification of craniotomy is the so-called *cranioclasm* of Simpson, in which after perforation a very heavy forcep-like instrument is used to break up the base of the skull.

The solid blade is introduced to the base of the skull through the opening, and the two are made to lock after the outer has been pushed as far down over the occiput as possible. Then by closing the blades forcibly, and giving them a twisting motion, the bone is to be broken. If necessary, the process may be repeated on the various sides of the head.

Cæsarean Section.

This operation consists in cutting through the abdomen and uterus of the mother, and extracting the child through the incision. It may be resorted to when the antero-posterior diameter of the superior strait, or the transverse of the inferior, is less than one

and a half inches; or, in other words, when it is impossible to deliver the mother in any other way, and when consequently both mother and child would inevitably perish.

The earlier the operation is performed in labor, the better the chance for both mother and child. It has sometimes been successful in saving the life of the child, when the mother has died during labor. For further particulars, the student is referred to larger works.

CHAPTER XX.

INDUCTION OF PREMATURE LABOR.

THERE can be no doubt that the fœtus is viable at the completion of the seventh month of utero-gestation, and there are many instances on record of children living who were born at a much earlier period. In some cases of deformed pelvis, in which all the children born at full time had been destroyed in the process, spontaneous premature labor has resulted in the saving of the child. It was such cases that first called the attention of obstetricians to the induction of premature labor as a regular obstetric operation. The risk to the mother is very trifling—scarcely, if at all, exceeding that of ordinary labor. It is said that on an average about one-half of the children are saved, notwithstanding mal-presentations are much more frequent than at term.

The class of cases for which it was first proposed, and has been most practised, are those in which the diameters of the pelvis are too much reduced to allow the head to pass at full term, and yet not sufficiently so as to prevent the passage of the fœtus at an earlier but still viable age.

The following table of diameters of the fœtal head is that of Mr. Figueira :—

AGE OF FŒTUS.	BIPARIETAL DIAMETER.	OCCIPITO-FRONTAL DIAMETERS.	OCCIPITO-BREGMATIC DIAMETER.
7th month.	2 in. 9 lines. . . .	3 in. 8 lines. . . .	2 in. 10 lines.
7½ "	3 " . . .	3 " 9 " . . .	3 "
8 "	3 " 1 " . . .	3 " 10 " . . .	3 " 1 "
8½ "	3 " 2 " . . .	4 " " " . . .	3 " 2 "
9 "	3 " 4 " . . .	4 " " " . . .	4 " 4 "

According to Ritgen, labor may be induced at—

	IN.	LINES.
29th week, when the antero-posterior diameter of the pelvis is	2	7
30th " " " " " " "	2	8
31st " " " " " " "	2	9
35th " " " " " " "	2	13
36th " " " " " " "	3	11
37th " " " " " " "	2	0

When the distortion is so great as to render the passage of a seven-months' child impossible, or where no reduction of a viable child's bulk will allow it to pass, abortion must be induced as soon as the pregnancy is discovered. Exostoses of the pelvis,

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previous rupture of the uterus, uncontrollable vomiting, fibrous tumors, etc., of the uterus, etc., may call for the same procedure.

OPERATION.—Oil of savin, ergot, cotton-root, and various other drugs, have been employed to bring on premature labor, but have been abandoned by the profession for more certain methods. There are four principal modes of operating. Of these, the most objectionable, the least practised, consists in rupturing the membranes with a female catheter or uterine sound. The liquor amnii escapes, and labor comes on with great certainty in a few hours. The objection to this mode is the great danger to the child from its long confinement in the uterus after the escape of the waters. A safer but less certain plan consists in separating the membranes from the cervix uteri for the space of two or three inches around the os. This is best done by means of a well-oiled catheter or bougie; if it fail, recourse may be had to another method of operating, and no harm will be done.

M. Kiwisch, of Prague, has proposed a plan which, as improved by Tyler Smith, is very easy of practice, and in most cases successful. It originally consisted in directing a stream of warm water upon the os uteri by means of a tube suspended from a height of about ten feet and introduced into the vagina. As modified, alternate streams of warm and cold water are employed, and one of the numerous syringes throwing a nearly continuous stream may be used. The stream of water should be kept up five or ten minutes, and the two may be used every two, three, or six hours according to the urgency of the case. This method is specially adapted, from its ready performance, to those cases of distorted pelvis in which it is very difficult to reach the os. This method is condemned by some as unsafe.

A more rapid and perhaps safer plan consists in introducing, by means of a speculum, conical tents of compressed sponge into the os uteri, a larger one being introduced every six or eight hours. It produces no perceptible irritation, causes labor in a short time, and shortens the first stage, at the same time preserving the membranes as long as possible, and thus favoring the birth of a living child.

The tampon or colpeurynter (a dilatable gum elastic bag, with a tube by which air may be forced into it) may often be used advantageously in conjunction with the sponge tent, and sometimes of itself is sufficient.

CHAPTER XXI.

UTERINE HEMORRHAGE.

UTERINE hemorrhage connected with the pregnant condition is best studied under three heads, or varieties, which have received the names of, 1. Accidental Hemorrhage. 2. Unavoidable Hemorrhage. 3. Hemorrhage after delivery.

Accidental Hemorrhage.

This generally occurs just before labor, of which it is indeed in many cases the immediate cause. Sometimes it happens during the labor and sometimes during pregnancy without causing premature birth. The immediate cause is, in most instances, *partial, premature separation of the placenta*. Occasionally it has other sources; thus, a varix in the os has been known to give rise to it. The exciting causes are various. Some of the most common are: mechanical injuries, such as blows, falls, etc.; exercise, anxiety, or mental excitement, undue muscular exertion, vomiting, straining at stool, etc.; general plethora, etc.

DIAGNOSIS.—In most cases the blood pours out through the vagina, and there is no doubt as to the hemorrhage. In such cases the only point for consideration is whether it be accidental or unavoidable hemorrhage; the diagnosis between these will be given under the head of the latter. It sometimes happens that the blood is poured out into the bag of membranes, or remains in the uterus between its walls and the membranes, and does not appear externally. This hemorrhage is *concealed*. Death may thus be caused without the hemorrhage being suspected. If a patient, who had been exposed to the exciting causes above detailed towards the close of pregnancy, should complain of dull aching pains in the back and womb, tenderness on pressure over the hypogastrium, and above all should exhibit the sudden general symptoms of hemorrhage, such as faintness, a tendency to yawn, nervousness, thirst, convulsions, etc., this condition may be suspected.

TREATMENT.—If the woman has not arrived at her full time, the hemorrhage is not profuse, and the os is undilated, an attempt should be made to prevent the threatened miscarriage. She should be placed on a hard mattress, with her head low, and be lightly covered. Cold applications may be made to the pubis, opium suppositories or injections used, and sulphuric acid or acetate of lead exhibited. If the hemorrhage continues the *tampon* should be applied. This consists of pieces of lint or masses of raw cotton introduced into the vagina one after another by means of a speculum, and closely packed in such a way as to fill it up completely. The mass soon becomes more or less saturated with blood, and acts as a plug restraining the exit of the blood. If the uterus be empty, or there be any tendency to concealed hemorrhage, of course the tampon would be worse than useless, since the blood might collect in the cavity of the uterus, the woman perishing without external signs of further hemorrhage. Thus the tampon is *never* used immediately *after* delivery. Ordinarily, before delivery, the vigorous womb refuses to allow enlargement of its already filled cavity, and if the hemorrhage continues contractions are excited. The tampon very commonly brings on labor.

When the woman is very near her time, and the os is considerably dilated, it is better to *rupture the membranes* at once and allow the liquor amnii to escape. This is generally followed immediately by active contractions which put an end to the hemorrhage.

If the uterus is very much relaxed and fails to contract in any

serious case of accidental hemorrhage, it is good practice to administer ergot. Probably it would in most cases be better, however, to produce version by the feet, and then exhibit the ergot and otherwise stimulate the uterine contractions.

If there be any delay in the expulsion of the after-birth, it is well to introduce the hand and extract it, rather than wait and thus run the risk of further hemorrhage in a patient already greatly exhausted. The after-treatment is to be carried out on general principles; stimulants and nutritious food being exhibited as required.

Unavoidable Hemorrhage, or Placenta Prævia.

In this affection the placenta, instead of being attached at the fundus uteri, is adherent to the lower segment of the uterus. Sometimes it is so inserted that its centre is applied directly over the os, or in such a way that one side only covers the os. When labor comes on and dilatation occurs, of course the attachment of the placenta to the tissue around the os must be sundered, the separation going on *pari passu* with the dilatation. This detachment gives rise to the hemorrhage, which, of necessity, must occur when the placenta is so inserted, hence the name *unavoidable* hemorrhage.

The first discharge generally commences when the cervix uteri begins to disappear between one and two months before parturition. There is no pain, no apparent exciting cause, and the amount is at first trifling. It recurs at irregular intervals through the remainder of the pregnancy, and when labor commences the flooding becomes frightful. The discharges may be seen to *increase during* each pain, and a vaginal examination will reveal the cause of the trouble. The placenta feels like a soft mass with a peculiar surface, firmer than a clot of blood; not, like it, breaking down under the finger. If it partially cover the os its edge will be felt continuous with the membranes through which sometimes the presentation can be distinguished.

Diagnosis of Hemorrhages before Labor.

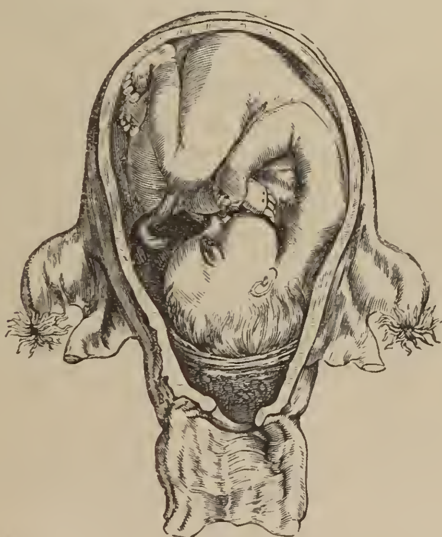
ACCIDENTAL.	UNAVOIDABLE.
Evident exciting cause.	No apparent cause.
Appears at any time during pregnancy.	Appears in the eighth month generally.
Mostly profuse at outset.	Trifling at first.
Often not recurrent.	Constantly recurring at intervals of days.
Decreasing as labor progresses.	Increasing during whole of first stage.
Lessened during pain.	Increased during pain.
Vaginal examination shows a normal os.	Vaginal examination reveals placental attachment.

TREATMENT.—When the hemorrhage first appears, it is mostly proper to endeavor to carry the woman to the full term, and the same general plan as in accidental hemorrhage is advisable.

Whenever the hemorrhage becomes excessive and the os is not

sufficiently dilated to allow active measures, the tampon should be used. This excites the uterine contractions and thus answers the double purpose of restraining hemorrhage and hastening the period for relief. As soon as the os is sufficiently dilatable, it is the duty of the accoucheur to bring about immediate delivery. The best way of doing this is by podalic version. The hand must be introduced into the vagina, folded in the usual way, pushed into the os *between* the placenta and the uterine wall, of course separating them. Some advise pushing the hand *through* the placenta, but the weight of authority is against this procedure. When the edge of the placenta is reached, the hand must break through the membranes and complete the version in the usual way. When the body of the child is in the vagina, it will act as a plug and thus check the hemorrhage, but as it is possible for internal concealed hemorrhage now to occur, the case must not be left to nature, but delivery must be finished as soon as possible by means of ergot and the use of the forceps. As soon as the child is born

Fig. 465.



PLACENTA PRÆVIA.

the placenta should be extracted by the hand if necessary. After this, great care and watchfulness must be exercised to prevent post-partum hemorrhage, and the treatment of the convalescence must be conducted on general principles. Under the most favorable circumstances the child is frequently lost. By some high authorities the following treatment of placenta prævia is recom-

mended : Rupture the membranes ; insert a tampon ; give ergot, and allow the tampon to be forced out before the head. Some years since Prof. Simpson proposed another plan of treatment of placenta prævia. Instead of version, he advised the tearing off and extraction of the placenta in the very commencement of labor. This does not give rise, as might be thought, to increased hemorrhage, because the uterus is in most instances excited to violent contractions, and the head is forced down upon the open vessels and arrests the bleeding by direct pressure immediately upon the complete detachment of the placenta ; even if this does not take place the hemorrhage almost always ceases. The objection to the plan is the almost necessary death of the fœtus. Labor in the presentation of the vertex always takes some time to complete itself, even when the position is favorable and the forceps are used early, and if the placenta be detached the fœtus is deprived of all oxygenation of its blood during this period. Notwithstanding this very valid objection, if, in any case, the woman be very much exhausted by profuse hemorrhage, it would be best to employ Prof. Simpson's plan as offering the best chance of safety to the mother. If there be any pelvic deformity, or if the child be dead, or so young as not to be viable, this is recommended by most authorities.

Post-partum Hemorrhage.

The discharge in this form of hemorrhage proceeds from the mouths of the vessels exposed by the partial or complete separation of the placenta. A certain amount of blood is usually lost immediately after the birth of the child ; it is only when the flow becomes profuse that assistance is necessary.

The most common period of its occurrence is immediately after the birth of the child, but it often occurs after the extrusion of the placenta, and is said to have come on several days after parturition. There would be in all cases of labor fatal hemorrhage from the opened uterine sinuses, did not the *contraction* of the womb close them. The uterine fibres are arranged in such a way as to form little muscular circles surrounding each of these large vessels, and when contraction takes place they are tightly closed. If, for any reason, contraction does not take place, profuse hemorrhage is a necessary result.

The ordinary cause of hemorrhage is uterine inertia, *i. e.*, a want of the normal tendency in the muscular tissue to respond to the ordinary stimulus ; sometimes the filling up of the uterine cavity with clots will prevent contractions and thus cause the hemorrhage.

The principal signs and symptoms are : the escape of blood from the external genitals ; the soft, large, flabby womb, as felt through the abdominal walls, sometimes so flabby as not to be definable by abdominal palpation ; constant and deep sighing ; dimness of sight ; recurring syncope ; ringing in the ears ; convulsions. There are some cases in which there is no escape of blood from the genitals ; these, from the facility of their danger being overlooked, are very perilous, and are spoken of as cases of "*concealed hemorrhage.*" Whenever, after labor, any of the symp-

toms of hemorrhage show themselves, or the woman complains suddenly of feeling faint, an examination of the uterus should be made to ascertain whether it be contracted, or whether internal hemorrhage is going on.

TREATMENT.—The indication is, of course, to *make the womb contract.* To do this, introduce the hand into the uterus as high as its fundus, and *turn out the clots*, constant external friction being kept up over the womb, whose fundus should be grasped every now and then through the abdominal parietes; administer ergot in large doses, and apply ice to the genitals; the cold should not be long continued, as, if its first impression do not bring about the desired contraction, there is little chance of the ice doing it at all. In most cases the hemorrhage now ceases, but if it do not, the practitioner must remember the urgent necessity for *immediate* action, and also that it is vain to hope for contraction with the uterus full of clots, of which it must be emptied as fast as they form. Now introduce *into the uterus* pieces of ice the size of a walnut, or even larger, and allow them to melt there; irritate the inner surface of the uterus with the hand; if these fail, soak a sponge with vinegar or solution of sulphate of iron, and squeeze it out into the uterus, or take a deeply gashed lemon with the outer rind peeled off, and squeeze out the juice in the uterus. If this fail, apply pressure to the abdominal aorta, just above its forking. Dr. Radford recommends galvanism as a powerful excitant of the uterine fibres.

If circumstances be such that it is practicable, transfusion of blood from a healthy person to the patient may be tried in sufficiently grave cases. It is believed in several instances to have saved life. Whenever there has been sufficient loss of blood to threaten syncope, the patient must be kept in a horizontal position, with the head lowered and the feet elevated, so as to keep as much blood as possible in the brain. For the same purpose it may often be advisable to use laudanum or some other liquid preparation of opium freely (say, tinct. opii, f℥ss, repeated in half an hour with caution, if required). Alcoholic stimulants must also, in exhausting cases, be administered, but withdrawn when reaction has occurred. During convalescence the treatment is sustaining, much the same as in hemorrhage from any source.

CHAPTER XXII.

ACCIDENTS OF LABOR.

Hour-glass Contraction of the Uterus.

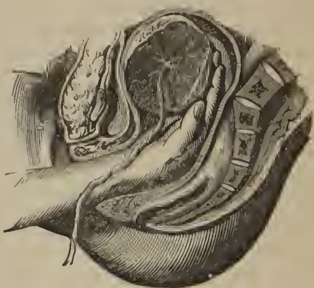
SOMETIMES after labor, owing to some weakening or derangement of innervation, the uterus contracts irregularly, spasmodically, and partially, some fibres contracting whilst others do not. In the true hour-glass contraction the fibres around the body of the uterus are thrown into a state of permanent contraction, giving

the womb something of the shape of an hour-glass and dividing it into two unequal chambers. In these cases there is very generally some adherence of the placenta.

Fig. 466.

HOUR-GLASS CONTRACTION OF WOMB.

Fig. 467.



REMOVAL OF ADHERENT PLACENTA.

TREATMENT.—The hand is to be introduced into the uterus in the usual way until the contraction is reached; this is to be overcome by gentle, steady pressure, with the ends of the fingers gathered into a cone, and when the placenta is reached it must be detached whole. The measures just described for producing uterine contractions are then to be used as required.

Morbid Adhesion of the Placenta.

The cause of this adhesion is some disease of the placenta, or of that part of the uterus to which it is attached, occurring during pregnancy. Thus, inflammation may cause an effusion of lymph binding the two together; calcareous and cancerous degeneration of the placenta are said to have produced it. As in most cases the contractions of the uterus separate a part of the placenta from its attachment, whilst the connections of the other portion retain the after-birth in the womb, and prevent contraction of the latter, the hemorrhage is often frightful. It is impossible to make out the diagnosis save by the introduction of the hand into the uterus and making the attempt to remove the placenta. If adherence be found, the placenta should be peeled off all around up to the adhesion, and the loose part then separated from the adherent parts. Too much violence should not be used to remove the fixed portion, which may be left in the uterus to soften and come away with the lochia. There is some danger to the woman arising from the decomposition of that which remains in the uterus, but if the adherent part be forcibly stripped off there is far greater

danger from inflammation. If, during convalescence, the vaginal discharges should be offensive, it would be well to freely use injections of tepid water containing permanganate of potassium or other disinfectant. Any symptoms that may arise must be dealt with on general principles.

Inversion of the Womb.

This may be complete or partial. Partial inversion may be recognized by the absence of the fundus above the pubis, and the presence of a large solid tumor in the vagina, accompanied by profuse hemorrhage, violent pain, tenesmus, vomiting, fainting, etc., clammy skin, feeble pulse, and more or less complete collapse.

The general symptoms of complete inversion are similar, but the tumor fills up the vagina and protrudes through the vulva. The os uteri may be felt at the upper end of the tumor, and the uterus is wholly wanting in the hypogastric region.

CAUSES.—Violence in extracting the placenta, shortness of the cord, atony of the uterus, and uterine tumors are some of the ascribed causes.

TREATMENT.—This consists in mechanically restoring the parts. If the placenta be adherent it is generally better to remove it first. For various methods of reduction, see larger text-books.

Rupture of the Uterus.

This accident may happen during a first labor but is more common in subsequent ones. All classes of women are liable to it; the healthy and ailing, plethoric and anæmic, the young and the old. Fortunately, however, it is very rare. The rent, which is generally oblique or transverse, may occur in any part of the organ; fundus, body, cervix, or mouth, and sometimes even the vagina and perineum are involved. Generally all the structures in the walls of the uterus are lacerated at once, rarely the peritoneal covering is not torn.

CAUSES.—The most common direct cause is *inordinate action* of the uterus itself, the muscle rupturing by the violence of its own efforts. It has been produced by improper efforts to turn, and even by the unskilful use of instruments. Previous inflammation of the uterine walls by producing softening and weakening of the tissue; very prolonged active labor, by pressure of the head on the walls, and exhaustion induced; injuries before labor; narrowing of the pelvic diameters by distortion; may be mentioned as occasional *predisposing* causes.

SYMPTOMS.—The woman suddenly cries out, generally in the acme of a strong pain, that something has given way in her, and manifests violent agony. If the rent is extensive, all uterine contractions cease; if it be small, they rapidly become more and more feeble and soon die away entirely. Then is felt in their place a constant agonizing pain in a fixed spot. Rarely is there any marked external hemorrhage.

Symptoms of collapse soon intervene; the pulse becomes rapid, small, fluttering, irregular; the respiration hurried and labored; the countenance anxious, dejected, hippocratic; the eyes sunken,

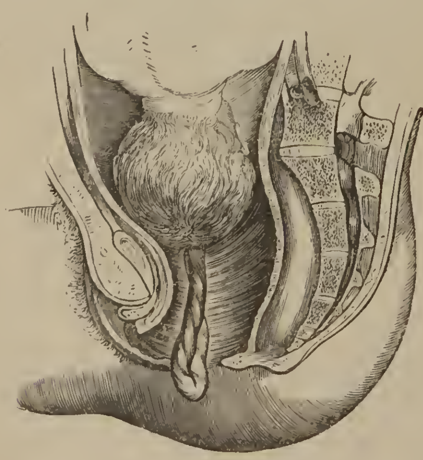
lustreless; the skin cool and moist; the abdomen swollen and tender. Mostly, in a few hours, vomiting of dark matters, hiccough, etc., come on, and the sufferer dies in collapse, of nervous shock. The *prognosis* is thus very serious; recoveries have, however, taken place. The *signs* of this accident, on examination *per vaginam*, are retrocession of the child's head, owing to a more or less complete admission of its body into the peritoneal cavity. Often the body of the child can be felt through the abdominal walls. Sometimes the head is so jammed into the pelvis that it cannot recede, and rarely the pain that ruptures the uterus forces the child into the world.

TREATMENT.—*Speedy delivery* alone offers any hope either to child or mother. If the head has not receded, this may be effected by the forceps. If the child is wholly or partially in the peritoneal cavity, the hand should be introduced through the rent, the feet seized, podalic version performed, and the child extracted through the rent and per vaginam. If, from rigidity of the undilated uterine mouth, or contraction of the uterus itself, the child, placenta, and membranes being in the cavity of the peritoneum, this be impossible, it may be advisable to cut through the walls of the abdomen, especially if the child be living.

Prolapse of the Cord.

This is a serious complication unless remedied, resulting in asphyxia to the child, through pressure on the cord and subsequent

Fig. 468.



interference with the placental circulation. It frequently calls for immediate delivery by instrumental means.

The most common *causes* of it are transverse presentations of the child, a large quantity of liquor amnii, excessive length of cord, sudden rupture of membranes and forcible discharge of the waters,

feet or knee presentation, insertion of the placenta on lower segment of uterus, etc.

TREATMENT.—If there be no pulsation in the cord the child is already dead, and it is useless to interfere. Various expedients have been proposed if the funis be pulsating.

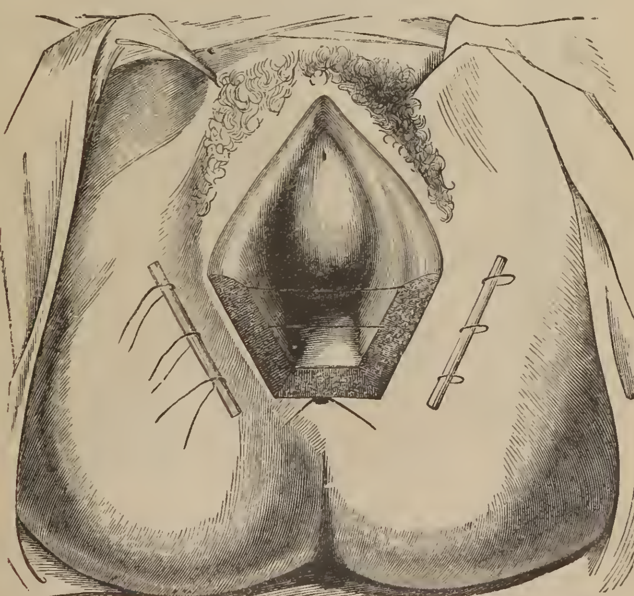
It has been proposed to push the cord up beyond the brim and keep it there by means of a sponge, until the head engages; or to hook it over the limbs of the child, or to inclose it in a little bag attached to a catheter, and then return it, the catheter being withdrawn and the bag left in the uterus. If the head has descended, use the forceps if possible. Before descent, version by the feet may be performed if the conditions are favorable.

Dr. Gaillard Thomas recommends that the woman be placed on her knees and elbows, so that her shoulders will be lower than her hips, thus making an inclined plane on the anterior surface of the uterus. While in this position, the hand should be passed into the vagina and the cord carried up and placed within the uterine cavity. After a few pains the patient may resume her usual posture, with the probability that the cord will not again descend.

Rupture of the Perineum.

This may occasionally attend either a natural or an instrumental labor. Slight laceration may heal spontaneously; when

Fig. 469.

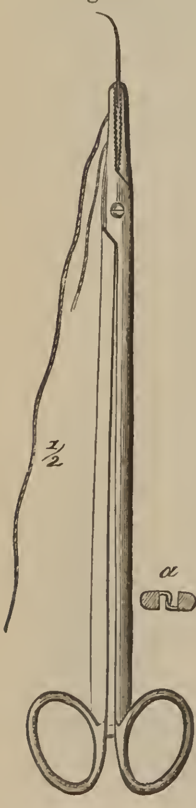


INSERTION OF QUILLED SUTURES (BROWN).

extensive, it requires an operation. Where the rupture is incomplete, it is right to endeavor to obtain union by keeping the patient at rest for ten or twelve days, with the thighs bandaged together; lying upon her side most of the time, to allow the lochial discharge to flow out through the anterior part of the vagina. The catheter should be used once or twice daily to empty the bladder; and the bowels should be allowed to be open as little as possible.

When a considerable laceration occurs at the close of parturition, *immediate* operation for the closure of the wound, with the view of obtaining union by the first intention, is advised by some excellent authorities. Yet, as the circumstances of the parturient woman are not always favorable for such a procedure, the practitioner must judge whether, in any case, it may not be better to wait at least for a few days.

Fig. 470.



Perineorrhaphy is the operation of paring the cicatrized edges of such a fissure, and uniting them with sutures. This mode of treatment dates from Ambrose Paré, in the fifteenth century; but has been especially successful since Roux (1832) introduced the quilled suture for its performance. Mettauer, of Virginia (1847), originated the employment of metallic sutures; and Sims, Bozeman, and others have continued and improved upon their use. Baker Brown divided the *sphincter ani* muscle to remove its resistance; but this is not necessary. Sometimes the laceration extends through the sphincter ani.

Vesico-Vaginal Fistula.

Various forms of traumatic communication between the vagina and the bladder, or the rectum, sometimes involving also the uterus itself, may follow delivery, with or without the use of instruments. Although such accidents are not common, their relief is very important, on account of the extreme inconvenience and distress they occasion. The essential principles of treatment are the same for all. Hayward, Mettauer, Sims, Bozeman, Agnew, and Emmett, in this country, and Simpson, Brown, Bryant, Wells, Simon, and others abroad, have done much to perfect these operations within comparatively a few years. The evidence of the existence of a vesico-vaginal fistula is chiefly of two kinds: the discharge of urine through the wall of the vagina, with the obvious results of this, viz., odor, dribbling, irritation, etc.; and the physical signs of the lesion, ascertainable by the touch, and with the aid of the speculum. If the opening from the bladder be very small,

its existence and locality may be made more certain by injecting water (perhaps colored, as with cochineal, or indigo) into the bladder, just before the inspection.

TREATMENT. — Except for the smallest openings, which are sometimes curable by *cauterization*, the operation by suture is required.

After the bowels have been emptied by a gentle cathartic, followed if necessary by an enema, the patient should be placed upon a table covered with two blankets, in the *semiprone* position; lying partly on the left side, but with the breast touching the table. An anæsthetic is then given; and a speculum is introduced, to expose

Fig. 471.

SIMS'S SIGMOID CATHETER.

Fig. 472.

Fig. 473.

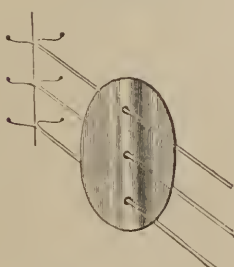
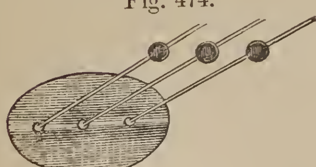


Fig. 474.



the fistula. Next, the operator pares the edges of the fistula, with long-handled scissors or a bistoury; the entire border being carefully removed. The metallic sutures are then introduced by means of slightly curved needles held by strong forceps. Another pair

of forceps is used to draw the needles through. Usually, however, silken sutures are first passed, silver wires being afterwards attached to these, and drawn through by them.

Twisting the wire sutures will then close the wound. Each suture is to be clipped with scissors, within half an inch of the place of union, and the end laid smoothly against the vaginal surface. After the bladder has been syringed to remove clots, a catheter (Sims's *sigmoid* being preferred) is introduced and left in the bladder. The sutures may be removed during the second week after the operation.

In Bozeman's operation, the knee-elbow position is preferred. A *suture-adjuster* is employed; and the wires are secured by means of a *button*, upon which are carried down a number (according to the extent of the fistula) of shot; these being prevented from subsequent slipping by firm compression with forceps. Agnew and others have proposed still different methods or modifications of this operation, which are described in special treatises.

CHAPTER XXIII.

PUERPERAL CONVULSIONS.

Hysterical convulsions may occur during any period of pregnancy, just as at any other period of a woman's life, but they are not true puerperal convulsions. They are seen in nervous hysterical women, more commonly, perhaps, in the earlier months of pregnancy. They are to be recognized by the hysterical temperament and history, the absence of frothing at the mouth, of the convulsive movements of the jaw, and of stertorous breathing. The insensibility also is more feigned than real, as will be perceived on pricking the patient with a pin, and the paroxysm is apt to terminate in a storm of tears and sobs, and is followed by a copious discharge of limpid urine. According to Dr. Dewees, there are violent contractions of the muscles of the back, which are almost pathognomonic. This affection must be sedulously separated from the true puerperal convulsions. It is of comparatively little importance. The treatment consists in the exhibition of the various antispasmodics, such as valerian, assafœtida, camphor, castor, etc. If the paroxysms are very prolonged, they may often be cut short by cold affusion. In a word, the treatment is that of hysteria in general, all strongly perturbating measures being avoided.

Many authorities, especially the older ones, speak of apoplectic convulsions. There is no such distinct variety. Apoplexy may occur at any time during pregnancy, either during or in the absence of a fit. There is no doubt that the convulsions predispose to, or indeed directly cause apoplexy, by forcing the blood with great rapidity and power into the brain, and thus rupturing some small vessel or vessels. This is, however, a *mechanical acci-*

dent of the fit. There is no vital connection between the apoplexy and the convulsion. Hence the incorrectness of interpreting such cases as a distinct affection. In the same way puerperal women may have attacks of tetanus or catalepsy, but all these must be distinguished from true puerperal convulsions, a disease *sui generis.*

SYMPTOMS.—These are best studied under three heads: 1st. Premonitory; 2d. Those of Attack; 3d. Those of the Intervals.

Premonitory.—According to Mr. Wriger, attacks occurring before labor are accompanied by premonitory symptoms in 40 per cent. of the cases, during labor 30 per cent., after labor 20 per cent. Their duration varies from a few moments to days. The most *diagnostic* symptom is a peculiar, very acute pain, occupying one half of the head, or perhaps only one parietal bone, or some equally circumscribed spot. It is generally accompanied by nausea, vomiting, vertigo, black motes dancing before the eyes, tinnitus aurium, etc. When the convulsions appear during labor, they are generally preceded by extreme indocility, restlessness, and peculiar irregular uterine contractions. Often the patient laughs and weeps alternately, or there is hebetude and stupor.

Symptoms of Attack.—The face is purple and turgid, and convulsed into hideous grimaces, the eyes remaining wide open and staring with dilated immovable pupils, the jaws working convulsively, the tongue protruding, often cut and bleeding, the nose sharp and pinched. At the same time the muscles of the trunk and extremities are violently convulsed, the *extensors* being much more powerfully affected than the flexors, and the spasm being rather tonic than clonic. All parts are in a state of permanent extension, and there is much less tendency for the body to be tossed about than in ordinary epilepsy. The pulse is at first full, quick, hard, afterwards it becomes very small and rapid. The respiration is interrupted, noisy, the air being thrown out with a very peculiar hissing sound. The urine and feces are evacuated involuntarily. Insensibility is complete. The uterus, if labor has commenced, sometimes partakes of the universal convulsion, and the fœtus is suddenly expelled; at other times it remains passive. The fits do not often last more than five minutes in the beginning, but they rapidly recur, and their duration generally lengthens. In labor they usually come on at the commencement of the pains.

Interval.—The woman generally awakes out of the earlier fits with an astonished air, and in a little while her mind becomes perfectly clear. But as they return, the comatose symptoms increase, until at last she sinks into a constant, profound coma, which presents all the symptoms of cerebral congestion, of which it is in truth the consequence.

The nervous symptoms of this affection are almost always preceded and accompanied by *albuminuria.* The amount of albumen in the urine increases greatly during the convulsive attack, and greatly diminishes at its cessation. All cases of albuminuria in pregnant females are, however, not affected with convulsions; according to Cazeaux, about one in five. This albuminuria is probably the result of acute congestion of the kidneys, at least in the cases attended with cerebral disturbance. In other cases

it may, perhaps, be due to passive congestion, caused by the pressure of the gravid uterus. It is generally associated with more or less œdema of the face and lower extremities, and may be looked on either as the cause of the eclampsia or as another expression of a deeper seated common cause of the two. The practical fact is the *urgent necessity of active treatment, when in a pregnant woman albuminuria is associated with any of the premonitory symptoms previously mentioned.*

TREATMENT.—This resolves itself into: 1st. Prevention; 2d. That of the paroxysm. 1. The condition of a woman before an attack of convulsions is that of *serous plethora*, and there is no doubt that the resulting tendency to congestion is one great source of danger. The indications plainly are to relieve the congestion of the kidneys, the serous plethora, and at the same time to alter and improve the condition of the blood, to lessen its water, to enrich its solid constituents, to cause to be excreted its urea and other products of retrograde metamorphosis. To fulfil these indications, either bleed from the arm or apply cups over the kidneys, and administer hydragogue cathartics and mild saline diuretics, of which *potassæ bitartras* is probably the best. If clearly required, do not be afraid at the same time to administer wine and good food. If the pulse indicate it, veratum viride or some other arterial sedative may be carefully given.

The convulsions are always accompanied by active congestion of the brain, if they be not caused by it. Hence, whenever the symptoms of an impending attack are threatening, *bleed;* also administer chloroform, or, as some recommend, ether.

2. During the attack, the indication for bloodletting is strengthened by the immediate danger to the brain from the existing congestion; hence some practitioners bleed freely from a large orifice. Bloodletting is usually well borne in this affection. Administer a quick, powerful cathartic, such as croton oil. Apply cold to the head, shaved, if the hair be very thick. *Inhalation of ether* is advised, especially in the *least apoplectic* form of puerperal convulsions.

If the attack occur during pregnancy, it is not good practice to attempt to produce abortion. Be not in haste to disturb the uterus, even though the child be dead. If labor has commenced, if the os uteri be dilated or dilatable, and the bag of waters unbroken, Cazeaux recommends podalic version. If labor be advanced, and the convulsions severe, the forceps should be used.

The attempt should be made during an interval, and the blade removed should a fit recur, for fear of injuring the soft parts of the mother.

CHAPTER XXIV.

MILK FEVER.

This sometimes appears as early as the first day after delivery, sometimes not until the fifth or sixth, but commonly on the third day. In very many cases it is so slightly pronounced as scarcely to be noticed. In others there are chills, headache, pains in the back and limbs, followed by high fever, with a strong, hard, quick pulse, and dry, hot skin. At the same time the breasts suddenly swell, and become hard and painful, and the lochia scanty. In a few hours the fever abates, often going off with a sweat, and the secretion of milk is established. Very-little treatment is generally required. In very robust, plethoric women, it may be well to administer a saline cathartic. If the breasts become very painful, and "cake," they should be thoroughly drawn, either artificially or by the child, and rubbed with belladonna ointment, or camphor and olive oil; if these do not relieve, leeching may be tried, and followed by warm fomentation. Should abscesses form, evacuate freely as soon as possible, poultice, and when the inflammation sufficiently subsides, strap the breast.

CHAPTER XXV.

PUERPERAL FEVER.

Under this name have been confounded two very distinct affections, or classes of affections: 1. Various inflammations. 2. One or more peculiar blood lesions. To the latter of these, the name puerperal fever ought to be restricted. After a short glance at the peculiar puerperal inflammations, we shall study puerperal fever properly so called.

Inflammations; Peritonitis; Metritis.—Peritonitis and metritis in the lying-in woman are so similar in their symptoms, so generally conjoined, and so identical in their treatment that they may always be looked on as one affection. They occur sporadically, are sometimes traceable to a cause, as instrumental labor, exposure to cold, etc., but are often apparently spontaneous. The general constitutional symptoms are those of severe inflammation, chill, marked fever, restlessness, strong, quick pulse, etc., to which are superadded great tenderness over the peritoneum, or uterus, as the case may be, with mostly severe pain in the parts, drying up, or other alteration of the lochia; dry, hot, red vagina, etc. Sometimes,

when the attack is severe, the system is apparently prostrate, the pulse rapid and small, the fever suppressed. The decubitus of the woman is significant, being that of ordinary peritonitis; she lies on her back with her limbs drawn up, her body supported by pillows and bent forwards; the object of this posture is evidently to relax the abdominal and crural muscles, and thus take off pressure from the parts.

The TREATMENT of these cases should be actively antiphlogistic; general bleeding, followed by free leeching. Opium should be administered in liquid form, so as to keep the patient in a state of semi-narcotism, and quiet the bowels. Purges are to be avoided, as causing too much disturbance. The pulse should be kept down by veratrum viride, or other arterial sedatives. Calomel, if the case resist treatment, may be pushed to incipient ptyalism. The diet should be, at first, unstimulating. Of course, if afterwards the case assumes a typhoid aspect, these measures should be replaced by supporting treatment.

Puerperal Fever, Childbed Fever, Peritoneal Fever, Puerperal Peritonitis of some authors.—This disease has been considered by many of the older authorities as a fever dependent on some local inflammation; but there is no doubt that it is a zymotic blood-poisoning, of which the various local inflammations are merely manifestations, and which in nature is almost identical with *erysipelas*, *pyæmia*, or perhaps even more closely, according to Simpson, with *surgical fever*. It is, in other words, a puerperal *ichoræmia*. Although denied by some, most eminent authorities believe it to be highly contagious, and that the *materies morbi* may be carried from patient to patient by the practitioner. More than this, several morbid poisons appear, in the peculiarly susceptible, *quasi traumatic* state of the womb after delivery, to produce the disease. *Erysipelas* does so, or at least the conditions productive of erysipelas; also the typhus poison; perhaps that of scarlatina and smallpox, etc. It is probably capable of being caused by the introduction of minute particles of animal matter in incipient decay, by the hand of the accoucheur who has been making post-mortem examinations, or dressing gangrenous wounds, before attending the parturient woman.

The SYMPTOMS are those of a low fever with the local manifestation of some inflammation. Thus the attack is generally ushered in by rigors, followed by high fever; at the same time there is generally nausea and vomiting; in the early stages the matters vomited are bilious, afterwards often resembling the black vomit of yellow fever, being in truth altered blood. The tongue is at first heavily coated, but soon becomes red, dry, chapped, and then dark, as the disease progresses. The skin is hot and dry, often yellowish. The pulse is soft and rapid. The mind is unsettled; there is at first merely some wandering, which may give way to active delirium, or more commonly, in the advanced stages, there is low muttering delirium, with extreme prostration, subsultus tendinum, carphologia, and all the nervous symptoms of the typhoid state. The urine is scanty, voided with difficulty, sometimes suppressed. There is generally diarrhœa throughout the attack, with very offensive passages. In a word, the constitutional symptoms

are those of pyæmia or surgical fever. In the worst cases, there seems to be a greater intensity of the poison, and a consequently more rapid giving way of the vital powers. The shivering fits are prolonged and recurrent, and there does not seem strength for the system to react into fever. The eyes are sunken and glassy, the respiration quick, hurried, it may be gasping; the skin dusky, perhaps studded with petechiæ; the pulse running and fluttering. At the same time the nervous system is profoundly affected; low muttering delirium, and perhaps coma, rapidly come on, and the patient sinks in a few hours.

Besides these general symptoms, there are various local ones. In most cases the abdomen is swollen, very tympanitic, painful, and tender; the milk and lochia are suppressed, or there may be gangrene of some of the external parts, or signs of purulent inflammation of the joints, lungs, etc., or phlebitis. When death takes place the immediate cause is mostly exhaustion.

There are no characteristic lesions of the solids to be found after death. In most cases there is metro-peritonitis, and the uterus is found very much softened, and its tissue broken down, the peritoneum injected, and containing largely of flaky ichorous pus; often there are marks of purulent inflammation of the uterine veins. Abscesses of the cellular tissue, joints, lungs, and liver; gangrene of the intestines or lungs, or cellular tissue, are occasional results of this terrible malady.

TREATMENT.—The treatment of puerperal fever, it must be confessed, has often proved very unsatisfactory. Venesection, purging, mercurials, etc., have been tried and most signally failed.

Our chief reliance is upon anodynes, tonics, sometimes stimulants, and a nutritious and easily digestible diet. The preparations of opium in full doses, quinine as a tonic, whisky or wine, with milk and beef-tea, though far from being successful in all cases, have been attended with encouraging results.

In some cases, leeches applied early to the abdomen, followed by poultices, have been found useful; so also have hot applications of water, alcohol, and spirits of turpentine. The latter may be given internally, in case of tympanites.

The *sulphites*, which have been found valuable in diseases characterized by blood-poisoning, are worthy of a thorough trial in puerperal fever.

If the lochial discharge become offensive, the vagina should be frequently syringed out with soap and water, or water containing the liquor sodæ chlorinatæ, the permanganate of potassium, glycerin, or some other disinfectant.

Especial attention should be paid to the ventilation of the apartment, keeping up a suitable temperature when necessary, by means of a good fire, and allowing a free admission of air through open windows and doors, carefully avoiding the passage of currents directly over the patient.

Preventive measures are essential. It is important that the placenta and membranes be entirely removed, a good contraction of the uterus secured, and the vagina emptied of all clots.

The possibility of conveying the *materies morbi* from one patient to another should not be forgotten or ignored by the practitioner.

If he be in attendance upon a case of child-bed fever, or malignant erysipelas, he cannot at the same time deliver a woman in labor without subjecting her to great risk.

If circumstances seem to render such a step unavoidable, the physician should first change all his clothing, and thoroughly cleanse his hands with some active disinfectant, with the hope that the danger of communicating the disease would thereby be greatly diminished, if not entirely removed.

It would be a safer course altogether to decline confinement cases under the circumstances named.

CHAPTER XXVI.

OVARIAN TUMORS.

WHILE various kinds of tumors, innocent and malignant, fluid, solid, and composite, are occasionally met with in the ovaries, the most important are the true ovarian cysts. Often these appear to be enlarged and dropsical Graafian follicles. Sometimes they result otherwise, from breaking down of the *stroma* of the ovary, and distension of its areolar tissue with fluid. This fluid has somewhat peculiar though variable qualities. It is usually clear and light straw-colored; albumen is a pretty constant ingredient.

Unilocular, *multilocular*, and *multiple* cysts are met with. The first consists of a single sac, the second of several, of which the smaller are growths (endogenous or exogenous) of the larger parent cyst; the third of two or more growing independently near each other. The liquid contained is generally thicker and darker in multilocular and multiple cysts. Such tumors may become very large, so as to accumulate fifty or a hundred pints of fluid. According to Thomas, the right ovary, according to Bryant, the left, is most frequently involved. About one case in eight is double.

Married women are most subject to this affection; especially between twenty and forty years of age. 56 per cent. of Bryant's cases have been cancerous. The duration of ovarian disease before death averages two weeks.

The *symptoms* of ovarian cyst are seldom clearly marked, although dull pain and a feeling of fulness are apt to be observable in the region of one of the ovaries. Dragging pain in the back or hypogastric region may occur later, with irritation of the lower bowels, and loss of general strength. *Physical exploration* is needed to determine the existence of an abdominal tumor.

When suspicion of it occurs, the abdomen should be carefully inspected with the eye and hand; if necessary, the patient being placed under the influence of an anæsthetic. An enlargement being discerned, it is to be discriminated from *adiposity*, *pregnancy*, *uterine tumors*, *tympanites*, and *ascites*. Adipose tissue is *equally* deposited, and may be lifted in masses or folds by the fingers. Pregnancy is to be determined by signs already laid down. (See Chap. IX.)

Uterine tumors are diagnosticated from ovarian cysts, principally by the following characters belonging to the latter: in ovarian tumors the uterus is not (as measured by the sound) enlarged; menorrhagia and leucorrhœa are not present as symptoms; the uterus may be moved without the tumor moving; there is generally but one tumor, and, if a cyst, fluctuation may be detected in it.

From tympanitic distension of the abomen percussion (giving an increased resonance in the latter case) and palpation will suffice for the diagnosis.

Ascites, or ordinary abdominal dropsy, is not always easy to distinguish from ovarian cystic enlargement. The following signs are the most important: in ovarian dropsy, the tumor begins on one side, extending over the abdomen as it increases; it retains its rotundity when the patient lies on her back, while in ascites it will flatter somewhat in that position; percussion resonance over the surface of the belly, when the patient is supine, is dull, instead of being resonant as in ascites, from the intestines floating upon the fluid in the peritoneal cavity; when she rolls in bed no wave is perceptible in the abdomen, as there will be in ascites; to vaginal touch, no fluctuating distension will be detected in "Douglas's cul-de-sac," between the vagina and the rectum; and, as a rule, no signs of disease of the heart, liver, or kidneys is present, as in ascites, to account for the dropsy. A fluid tumor is distinguished from a solid one by palpation, and by *fluctuation* when gently tapped at one part, while a finger is in contact with another part of the enlargement. Drs. Atlee and Drysdale insist on the importance in diagnosis of the *granular ovarian cell*, discovered in the fluid of a cyst, when this is withdrawn and examined under the microscope. Other observers, however, do not all admit that such cells are peculiar to ovarian tumors, as they are similar to the "inflammatory corpuscles," exudation corpuscles, or pyoid globules of Gluge and other pathologists.

Between unilocular and multilocular cysts, it is often difficult to determine, unless their growth be exogenous, so as to be felt on palpation. Exploration with a hollow or grooved needle, hypodermic syringe, or Dieulafoy's aspirator, will assist this inquiry by exhibiting mostly a clear straw-colored fluid in unilocular tumors, and one more resembling honey in the multilocular. The length of the pedicle, and the presence or absence of adhesions, can only be conjectured, without an exploratory operation by incision. When the tumor is found, by vaginal touch, to be high up above the pelvis, the pedicle is unlikely to be short, and *vice versa*.

Tapping has often been resorted to, both for diagnosis and for palliative treatment. It is not free from danger to life. Kiwisch has estimated the deaths following it at 17 per cent.; from shock, peritonitis, or septicæmia. It is considered, also, to promote adhesions, which may obstruct the subsequent performance of ovariotomy.[1] The reasons in favor of tapping are, that it yields a

[1] While Bryant emphasizes these objections to tapping, he incidentally asserts that the liquid of a cyst is easily absorbed from the peritoneal cavity, and that adhesions resulting from tapping seldom afford much resistance.

considerable temporary relief, with decidedly less danger than an operation with the knife, while it may, by inducing a change in the dimensions of the abdominal cavity without much disturbance, prepare it for the more serious traumatic condition involved in ovariotomy; this being afterwards to be performed if required. A cure has, in a few instances, followed tapping. Should death result from it, the operator can seldom doubt that this would have likewise attended the major operation, if that had been done instead, while a good condition after tapping renders ovariotomy in the same case more hopeful. Among successful operators, Clay, at least, asserts that the mortality of cases is not increased by tapping. Still, it cannot be said to have at present the approval of the majority of ovariotomists.

Explorative incision is considered by Thomas not to involve, if skilfully performed, much greater risk than tapping or puncture. All preparations being made as for ovariotomy, an incision is made on the median line, one inch in length. The finger can then *explore* the tumor; and this examination may be assisted by tapping the cyst with a very small trocar, or the pneumatic aspirator.

TREATMENT.—Medicines have been abandoned as hopeless of utility in ovarian tumors. Besides *tapping*, *injection* of a solution of iodine into the sac has been tried by a number of practitioners with variable results. Peaslee advises the restriction of this operation to "the simple sac, with clear serous contents; and this should have been tapped once at least previously, as a general rule."

Drainage is sometimes resorted to by means of puncture of the cyst from the vagina, a metallic or elastic tube being inserted and retained, so as to carry off the fluid as it is reproduced. Noeggerath's operation includes stitching the lips of the cyst to those of the vaginal wound with silver wires.

Drainage through the abdominal walls has also been tried in cases not favorable for other treatment, as in multilocular or firmly adherent cysts. In 32 cases collected by Thomas, after this operation, 20 ended in cure, 12 in death.

Partial excision of the cyst is thought of by surgeons in some instances of unilocular cyst with irritating fluid contents. The liquid is, in this operation, allowed to pass into the cavity of the peritoneum.

Ovariotomy.

Dr. Ephraim McDowell, of Kentucky, first performed this operation with success in 1809. Meeting with much opposition for a length of time, it is now one of the accepted resources of surgery, although still having a mortality of nearly one case in three, and requiring much care in selection as well as skill in its performance. Clay, Wells, Keith, Baker Brown, and Bryant are especially named in connection with it in England, and Atlee, Peaslee, Kimball, and Dunlap in this country. In Germany and France it has been slow of introduction. Its chief *dangers* are *peritonitis*, *septicæmia* or *pyæmia*, and *shock*. These are lessened considerably by recent improvements in the procedure.

When shall ovariotomy be performed?—It is *not* called for when

the tumor increases very slowly (which is most likely to be the case late in life), giving little inconvenience, and not interfering with the patient's general health. If tapping has been performed, great relief afforded by it may *postpone* the operation, especially if a fluid containing little or no albumen be withdrawn.

Conditions favorable to the operation are thus set forth by Thomas:—

Clearness and certainty of diagnosis;
Good constitutional condition;
Patient hopeful in mind;
Unilocular character of cyst;
Absence of solid matter in it;
Abdominal walls not very thick;
Absence of adhesions and of ascites;
Small amount of albumen in fluid of cyst.

Great carefulness in diagnosis is indispensable; especially to ascertain, 1. That the tumor is ovarian, not uterine; 2. That it is not cancerous; 3. That its contents are fluid; 4. That the fluid is ovarian, not ascitic; 5. That pregnancy does not coexist with the tumor.

In some rare cases, a small tumor has been safely removed through the vagina, by making an incision through its posterior wall into Douglas's cul-de-sac. In a case reported by Thomas, the pedicle was secured by ligatures, the ends of which were cut off and returned into the abdominal cavity; the vaginal incision being then closed with silver suture.

Preparation for ovariotomy.—The system of the patient should be brought into the best possible condition by good diet, and the moderate use of quinine and iron. Bryant thinks that the latter tonic lessens the danger of erysipelas. The operation should never be performed in a crowded general hospital. If possible, a private house in the country should be preferred.

The bowels must be opened the day before the operation by a gentle laxative (as castor oil), and the rectum emptied by enema shortly before placing the patient in position. A time should be chosen at least a week after the menstrual period. Opium is given, a grain every six hours, by some practitioners for four days, as a part of the preparation; but this is of doubtful advantage. Atlee gives a dose of opium an hour before operating.

The temperature of the room should be about 70° Fahr.[1] The bladder must be emptied by means of the catheter as the last part of the preparation. The patient is then to be placed on her back, and the anæsthetic administered. Four assistants are needed; one to superintend the etherization, one to apply ligatures, cautery, etc., one to hand instruments or sponges, and one to aid, if necessary, in manipulating the tumor, adhesions, etc.

The hands of the operator must be scrupulously clean; and no one ought to be allowed to be present, who has recently been in contact with erysipelas or puerperal fever.

The steps of the operation are the following: 1. Incision; 2.

[1] Bryant says 65°; Thomas, 78° to 80°.

Exploration for and rupture of adhesions; 3. Tapping the tumor; 4. Removal of the sac; 5. Securing the pedicle; 6. Cleansing the peritoneal cavity; 7. Closing the incision in the abdomen.

Fig. 475.

The opening of the abdomen ought always to be regarded, in the first place, as an *exploratory operation*. The diagnosis may be incomplete without it; and, after it has been made, the character or conditions of the tumor may make it inexpedient to attempt its removal.

Whether the incision be made short or long, should depend on the size and shape of the cyst or cysts. Surgeons do not consider the danger to be greatly increased by prolonging the abdominal opening, if needful, from a point about an inch above the pubes even to or beyond the umbilicus. When the muscles have been divided, and hemorrhage arrested, the *parietal* peritoneum is to be slit upon a director. Then, usually, the smooth glistening surface of the *visceral* peritoneum is discerned, covering the cyst. Sometimes, however, a vascular appearance is presented, from hypertrophy of the bloodvessels of the broad ligaments. This state of things requires especial caution in order to avoid troublesome hemorrhage. *Adhesions* must now be sought for. If they are slight, the fingers passed around the tumor will suffice for their detachment. Sometimes they may require the use of scissors, a small *écraseur*, or the actual cautery. Hemorrhage from lacerated adhesions may be treated by touching the parts with persulphate of iron solution, or the actual cautery lightly applied. *When adhesions of the cyst or cysts to the abdominal and pelvic viscera are firm*

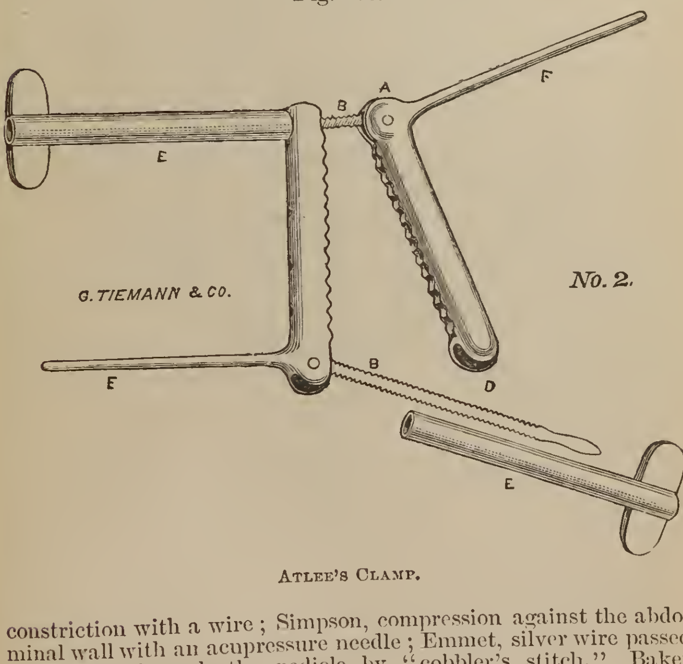
and extensive, it is the safest practice to abandon the operation of removal, and close the wound.

Removal of the sac of the cyst is the next step. This is to be done by drawing it (previously secured from returning to the abdomen by tenacula or forceps) gently out with the fingers.

The pedicle must next be disposed of; so as to prevent hemorrhage. Two plans are open to the judgment and option of the surgeon: to retain it outside of the peritoneum and between the lips of the wound; or, to return it to the abdomen, after securing it against hemorrhage. For the former, either *ligatures* or *clamps* may be used. Dr. Storer also forces the skin (after applying ligatures) so as to cover the pedicle and wound.

For preparing the pedicle to be returned, either *ligatures*, *actual cautery*, the *écraseur*, or *compression* may be resorted to. Clay uses a double ligature, so as to tie the pedicle in *two parts*, the ligatures being allowed to hang out of the lower angle of the wound. Greene has employed the same mode of ligation, but making the ligatures to hang into the *vagina*, by an opening into it from within the pelvis. Tyler Smith's plan is to cut the ligatures short and then return the pedicle with them. Kœberle has used temporary

Fig. 476.



ATLEE'S CLAMP.

constriction with a wire; Simpson, compression against the abdominal wall with an acupressure needle; Emmet, silver wire passed repeatedly through the pedicle by "cobbler's stitch." Baker

Brown preferred the actual cautery; Atlee has made frequent use of the écraseur.

If the pedicle is not to be returned, the *clamp* affords great facility of application. Several kinds are employed; especially Wells's, Atlee's, and Kœberle's.

Whatever plan, in reference to the pedicle, may be resorted to, much care must always be taken to prevent hemorrhage; but *sponging* is to be done with great delicacy, and sometimes may be entirely avoided. The *softest* sponges only must be used.

In regard to the modes of treatment of the pedicle above mentioned, Thomas propounds the following suggestions:—

"The clamp is applicable to long pedicles, requiring powerful ligation, and presenting a large amount of tissue for suppuration and decay.

"The écraseur may be relied upon where the pedicle and vessels are small.

"Clay's method is eminently adapted to cases in which considerable suppuration is anticipated, and a vent for pus is required; as, for example, where many adhesions have been broken.

"Tyler Smith's method may be resorted to with confidence where the pedicle is small in volume, where no great disturbance of the peritoneum has occurred, and where we have no reason to anticipate suppuration.

"Kœberle's constrictor is applicable to just the same class of cases as the method of Dr. Clay, and for the same reasons.

"The severance of the stump by actual cautery presents many advantages, and may be used in any case except where the vessels are very large."

W. W. Greene is reported to have given up his proposed plan of drainage through "Douglas's cul-de-sac" into the vagina. But Marion Sims has advocated it; and the reasons in its favor are strong, if a complete method of drainage can be secured.[1]

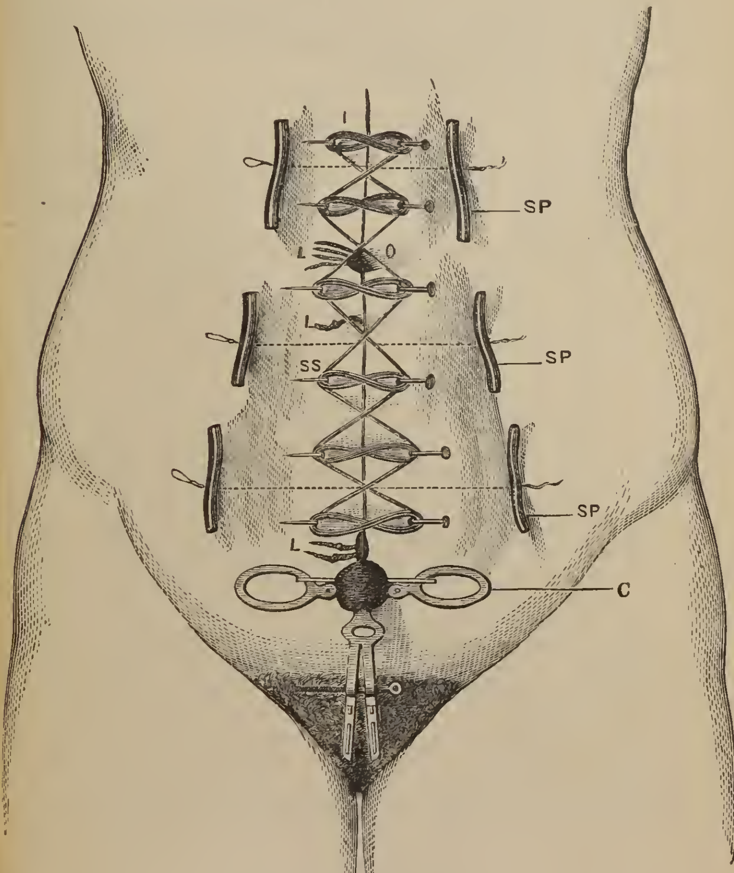
Closure of the Wound.—Bryant prefers ligatures of fine silk plait, both for the deep and the superficial sutures; and he does not consider it important that the former should include the peritoneum. Thomas directs that the deep sutures should be introduced in the following manner: A thread of silver wire is passed at each of its extremities through a long and stout straight needle. One of these needles is then to be grasped by strong needle-forceps and passed through the peritoneum of one abdominal flap near the edge of the incision, and made to emerge through the skin about an inch from the edge. Then the other needle is seized and passed likewise through the other side. The suture is then secured by twisting the wire. These deep sutures should be about half an inch apart. Besides these, superficial *hare-lip* sutures should be applied, involving the skin but not the peritoneum. Over the whole wound lint should be applied, either wet or spread with cerate.

After-treatment.—When the operation is completed, an enema containing (in a small amount of starch) sixty drops of laudanum,

[1] See, upon this, a paper by Dr. A. J. C. Skene, New York Medical Record, October 1, 1873.

or a suppository of cacao-butter with half a grain of sulphate of morphia, should be introduced; the patient being put into a warm bed in a quiet, airy room. Nourishment, in the form of milk,

Fig. 477.



KŒBERLE'S METHOD.

arrowroot, and, a little later, beef-tea, should be administered in sufficient quantities to support the system without loading the stomach. The bladder must be emptied at proper intervals by means of the catheter; and, when the bowels require relief, an enema of warm soap and water will prevent injurious straining.

Upon the use of opium, often advised as a part of the after-

treatment of ovariotomy, as well as of other serious surgical operations, Bryant makes the following judicious remarks :—

"Opium, carefully given to allay pain and cause sleep, is a drug upon the value of which there is no room for doubt. But opium administered with sufficient freedom to bring, and repeated often enough to maintain, a patient under its influence, is a drug in the use of which a surgeon should be on his guard. In ovarian cases it should not be given in larger quantities than are found sufficient to allay pain and secure sleep."

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